

# DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

Edited by HUGH POLLARD

Volume VI

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# DISCOVERY

## A Monthly Popular Journal of Knowledge

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## Editorial Notes.

THIS is a very pretty problem that Professor Gilbert Murray has set us, this business of thought transference or telepathy. How is it to be explained? How are we to account for it? His own theory is that by some unexplained process his own mind becomes super-sensitive, so that he gets direct knowledge of the other's thought. He apparently does not believe that it is some new "unknown power," and it is very definitely expressed that it is entirely distinct from anything we associate with "spiritualism," that is to say, alleged communications between the living and the dead. Mankind has long believed in the possibility of thought-transference, but it has been a subject difficult to investigate. There was much hearsay but little evidence. Mass experiments in America have been tried, a large body of students concentrating at a given hour on transferring a mental picture of a given diagram or word to students waiting elsewhere in an appropriately receptive state. The results obtained looked encouraging until someone with an unromantic mind and a talent for mathematics demonstrated that they showed precisely the right proportion of successes and failures. It was, he pointed out, with his discouraging bits of algebra, exactly the same as any other guessing competition. The Society for Psychical Research has materially bettered this, for,

according to newspaper report, Professor Gilbert Murray was right five times out of ten, and gave correct answers describing very complex happenings.

\* \* \* \* \*

In Britain most of our men of science are somewhat shy of dealing even experimentally with such nebulous matters. There is much to be said in support of this attitude. Many marvels are related, but it is provokingly seldom that anything as definite as this occurs. It is also extremely satisfactory that Professor Gilbert Murray, Lord Balfour, and other people of equal critical powers and reliability were concerned in it. You will notice that I do not say honestly. I have met many sincere and honest people who believed in extremely queer things which did not seem to others who looked more critically into them to be worthy of any attention at all. I have even been to an extremely advanced spiritualistic circle where substantial phenomena and the very hottest kind of wizardry were being investigated on what, I was assured, were absolutely scientific lines. They had a mirror galvanometer which was being used for indicating the "psychic force" of members. Two metal handles were attached to wires and you held one in each hand. The deflection indicated your psychic force. This not unnaturally varied with the moisture of the hand, but this had not occurred to them as an explanation. In fact, the suggestion was vigorously repudiated, and the demonstrator procured a pear into which he thrust the handles, thus making a very effective little electric battery. "That proves," he said impressively, "that the life force exists even in the vegetable kingdom"! The next time I went I put a substantial horseshoe magnet in my pocket, for I thought that it might bring me luck. It did. The galvanometer nearly grew hysterical and my extraordinary psychic gifts were the envy of all present. Even a complete disclosure of this uncanny gift's real origin failed to shake them. "There must be something psychic about it," they insisted. "Magnet or no magnet, the instrument for indicating psychic force indicated psychic force. You *must* have it." Then

a lady at the back solved the problem for everyone. She had just had a message from a spirit to say that the magnet simply concentrated the psychic force—that was all. They were perfectly honest, but I still hold myself at liberty to prefer my own view of the facts.

\* \* \* \* \*

What, after all, do we know about the human mind and its working? Do we even know nearly everything about our senses? Why, in this number of *DISCOVERY* you will learn that it is only recently that we satisfactorily solved certain problems of how we hear. There are all sorts of little everyday commonplaces that are essentially mysteries still. For instance, do you quite understand how a ventriloquist works his tricks? The psychologists of to-day are skilful in matters concerning complexes, but they do not seem to have much that is new to say about thought-transference. We must go back to that entertaining if rather discredited French school who have recorded their experiments and experiences while exploring supernormal phenomena. They have always had a taste for the odd phenomena of hypnotism, suggestion and mesmerism.

\* \* \* \* \*

"Psychic Science" by Emile Boirac and "Psychical and Supernormal Phenomena" by Dr. Paul Joire are both books which cover a wide field of peculiar subjects in a fairly critical manner. Opinion may be divided on the value we should place on their chronicles or their conclusions, but they afford entertaining reading and approach these matters on scientific rather than partisan lines. In the United States a committee, under the auspices of the *Scientific American*, are carrying out a very careful examination of so-called spiritualist phenomena. The committee contain a proportion of qualified scientists, an even amount of believers in the reality of the phenomena, and a neutral element. The investigation has been undertaken seriously, and time and money are being spent in a careful trial, first of all, to see whether there are any phenomena; secondly, if there are any, to determine how they are produced. The investigation is still proceeding, and no considered opinion will be issued until the series of experiments are at an end. Such interim reports as have been issued do not indicate that any new matter of scientific interest has transpired. It is, however, a good thing that from time to time there should be a properly conducted investigation of these matters. It has been well said that "the mystics are usually right in their facts, and the scientists right in their interpretation of the facts."

The main obstacle to thorough scientific investigation of these things is a serious one. In nine hundred and ninety-nine cases out of a thousand there are no facts. If anyone can provide the thousandth case and produce facts, there are suitable people prepared to look into them.

\* \* \* \* \*

I have an apology to make, not about a gross grammatical blunder in the last number. I have of course, suffered all sorts of punishment for that. It varied from a hearty bludgeoning to the most delicate of poisoned barbs, and only an iron constitution pulled me through. It was, I feel, beyond all apology, and it has so shaken my nerve that it is not improbable that I shall do something just as incredibly silly again. No, the apology is due to about seven hundred people who sent in their cards asking for a specimen copy. We sent off back numbers to the first few hundreds and then ran completely out of supplies. The demand was far greater than had been anticipated and still cards kept on coming in. Hundreds of them. There was only one thing to do which was to acknowledge all cards and send out copies of this January number. The paper will therefore be new to many readers, and a restatement of its aims is necessary. *DISCOVERY* is endeavouring to establish itself on a sound basis as a popular journal which covers all recent developments in science and knowledge. The wide field thus embraced can be judged by a glance down the index of last year's volume, which is included in this number. The basis of the journal is that every article is sound in fact, written by an expert and expressed so far as is possible in simple language. We are endeavouring to fill the need for a journal which does not treat scientific subjects in the inaccurate manner of the sensational press, yet which gives them in a clear, accurate and popularly readable manner.

\* \* \* \* \*

We believe that the journal is doing useful and educative work and that the time has come for it to enter on a phase of expansion and development. We need far more subscribers and readers than we have yet reached, and we ask for the help and support of those interested in the advancement of science and knowledge. It is a paper worth supporting, for it has a definite purpose to achieve. It can be ordered through any newsagent or bookstall or we will send it post free anywhere in the world for twelve shillings and sixpence a year. A specimen copy will be sent free to anyone likely to be interested if you will forward us a postcard giving the name and address.

## Witch Doctors and Native Medicine-Men.

By C. J. S. Thompson, M.B.E.

Curator of the Wellcome Historical Medical Museum.

*The Ju-ju man is still a figure of horror and mystery. The author has had the opportunity of examining the strange contents of many of their medicine bags, which throw some light on their methods of healing the sick.*

THE causation of disease, as believed by primitive people throughout the world, may be traced back to prehistoric times. From the earliest records, probably going back 5,000 years, we find the prevailing idea that the cause of disease in man was due to some demon or evil spirit which took possession of his body. Thus in a Babylonian tablet from the library of Assur Banapal, which is said to date from 3000 B.C., there is a formula of exorcism, which is translated as follows:

"Against the head of a man,  
exercises his power the excrable Tapa,  
Against the life of a man, the  
cruel Nampa,  
Against the neck, the dreadful  
Tiga,  
Against the hand, the shocking  
Zeelal,  
Against the chest, the terrible  
Alal,"

and so on.

In contrast with this ancient formula, the Cingalese of to-day have even further divisions of the body, and classify their demons according to their power and the symptoms produced. Thus they have a Demon of Deafness, a Demon of Blindness, a Demon of Cramp, a Demon of Fever, and of other morbid symptoms. These conditions are represented by masks like human faces, painted red, yellow, blue and other bright colours. They employ the mask for the exorcism of the demon in the following way. The native medicine-man builds a small hut with a great number of niches, in each of which he places one mask. Before the mask he makes a small altar upon which he sacrifices to the demon while the patient lies down upon a litter. After the sacrifices,

he puts before his face the suitable mask and dances round the patient until, being exhausted and probably hypnotized, he falls to the ground. After this the patient is sent to his home and is supposed to be cured.

The object of the primitive practitioner of healing is to rid the body of the intruder who is causing the mischief. His methods are both physiological and psychological. In the physiological may be included such operations as trepanning with flint knives and scrapers, the opening of abscesses with similar instruments, cupping and the use of fumigation of various parts of the body. Among the psychological methods may be included incantations, charms and the use of fetish figures, hideous masks, rattles and drums, all of which form part of the general treatment carried out by the medicine-man or witch doctor. Among barbaric races, the medicine-man is an important personage, and in some tribes is even more powerful than the chief. His position is often a special and



AN AFRICAN MEDICINE-MAN'S COSTUME.  
The figure is shown holding a ju-ju or medicine bag.

remarkable one, and his power and influence are usually very great.

### Some Methods of Healing employed by the Medicine-Man.

The methods employed by the medicine-man or witch doctor for driving out the disease demon or evil spirit from the sick person vary with the tribe to which he belongs. Usually the beating of drums, the shaking of rattles, bells, clappers and other noisy instruments are employed as first treatment. The bells are generally made of metal. The rattles consist



IVORY AND WOODEN CHARMS USED AGAINST  
SLEEPING SICKNESS.

From the Babundas, Bapende and the Congo. (Wellcome Historical  
Medical Museum.)

of large nuts with the seeds inside, or dried gourds in which small pebbles have been placed and then tied to a stick. Horns are also used, made from tusks, and wooden whistles often carved in the shape of birds.

Fetish figures carved in wood also play an important part in the treatment of the sick. The connexion between the fetish figure and the primitive practice of medicine is twofold. First it may be used as an amulet or means of enchantment, or the spirit which affects it may be adjured to grant a petition or drive away the malignant demon that causes disease or misfortune.

In many of these fetish figures, especially those used in Africa, there is a cavity in the abdomen, generally covered by a piece of glass, behind which the so-called "medicine" is placed. The treatment of healing proceeds as follows. After certain incantations, the proper remedy is placed in the figure. It is rarely administered to the patient, but occasionally some of it is mixed with palm wine and given to the sick person, in the belief that if the demon escapes, the fetish will bring terrible punishment upon it. In some parts of the Congo region it is customary for the medicine-man to put a wood figure in some secret place in a wood or jungle. A person who desires to give his enemy pain will go to the medicine-man, who will then insert a sharp nail into the fetish, in the belief that this will cause the enemy severe pain in the arm, leg or other part of the body. If the

death of the enemy is desired, a nail is driven into some vital part such as the stomach or heart.

This figure is regarded as a mere piece of wood until it has been in the hands of the medicine-man, who puts into it the proper charms or smears it with the proper "medicine."

In Mashonaland the medicine-man often employs divining bones to diagnose the complaint of a sick person, for their object is to discover the enemies who may have bewitched him, or the particular demon which has to be appeased by sacrifices, and has made known its desire by visiting the patient with mysterious illness. These are made of Shaka wood, one of the few timbers into which the familiar spirits of the medicine-man deign to enter, those of other trees being said to "lie" by the tribe to which the medicine-man belongs.

#### Colour Effects.

Among the Boloki of the Upper Congo, witch doctors use a curious charm to ward off sleeping sickness. A small clay bowl is painted bright yellow with red and green spots, and in it are placed a number of twigs cut from a shrub. Over the bowl is erected a little hut or shelter to preserve the charm from weather or decay and so protect the sufferer from serious relapses. Another charm, employed to relieve rheumatism, lumbago, malarial fever and debility, is practised as follows. Two posts about five feet long are erected near the hut of the patient, and are painted bright yellow with red and green patches. This is done to entice the demon to leave the sufferer and enter the posts. Sugar cane, wine and food are placed on the posts to attract the evil spirit, and the tops are connected by pieces of native twine in which loops are tied, designed to catch the disease-dealing demon should it try to escape. Should a bird become ensnared in one of these loops, it is regarded as a visible embodiment of the demon of disease who has been caught in this guise.

Among the forest and menial tribes of Northern India, the Begat or healer squats beside the patient speaking some meaningless words which are regarded as a kind of oracle. He then waves round the head of the patient a bunch of peacock feathers which is supposed to drive away the evil spirit causing the disease. The Vedas of Ceylon are treated by the medicine-man holding a bow balanced by the string while he recites an invocation to determine to which Yaku or spirit of the dead the patient's illness is due. When the right name is spoken the bow is said to swing to and fro. The Shaman or witch doctor of the Dakota Indians claims to be able to expel the

evil spirit that causes the disease, first by calling on the aid of some other demon by means of incantations and ceremonies, and then by making noises and sucking various parts of the patient's body with a hollow bone. He then discharges a gun which is said to destroy the demon as it passes by the door of the tent. Among other American Indian tribes, massage, fumigation and a primitive form of hot-air bath are also employed.

The native medicine-men in Central and East Africa deal largely in charms which they sell at high prices. The Babundas, Bapende, and other tribes of the Congo district wear charms to prevent sleeping sickness. These are generally carved in ivory or bone or fashioned in brass, and represent native heads, the eyes having the heavy-closed lids so typical of the disease. A ring of rhinoceros hide is worn as a protection against fever in Nyassaland, and an armband of snake-skin is believed by Kafirs to prevent rheumatism. A leopard's claw or a crocodile's tooth carved with a small fetish head is commonly used on the Congo as an amulet against disease, and among the Bagongo small antelope horns filled with a mixture of herbs and animal substances are believed to endue the owner with powerful protective properties against various illnesses.

#### The Dress of the Medicine-Man.

The dress of the medicine-man, when he wears any costume at all, is usually of a weird and fantastic description, and varies according to the tribe or region to which he belongs.

In some parts of Africa, especially in the Congo region, a complete costume of native string, either closely or loosely woven, is worn. It is generally made in one piece and covers the body from the neck to the legs, a long fringe being left round the wrist and ankles. Some have a long tail appended, reaching to the ground, while round the waist a girdle of twisted fibre is worn, from which hangs the bag.

In parts of East Africa, the medicine-man wears a closely-woven tunic, with a skirt or kilt composed of the pelts of animals. Skins are also sometimes worn, hanging from the shoulders. In other districts, the medicine-man's dress consists of a necklace of beads and a decorated loin cloth.

The devil dancers' masks are usually grotesquely carved and painted, and are generally made of wood, sometimes covered with skin, and the faces are made more hideous by being daubed and painted in various colours. Some are surmounted by the figures of leopards or other animals, and from the chin a long beard sometimes hangs, which reaches to the waist.

Among the South African native tribes, the medicine-man rarely wears an elaborate costume, but decorates himself with beaded scarves on which bells are sometimes hung, and he often paints his body in various colours. Kafir witch doctors, however, sometimes don a very elaborate dress consisting of a head-dress of feathers and shells, with a curious mask over the face. The rest of the body is covered with a robe made chiefly from skins and grasses decorated with beadwork.

In contrast with their fellows of the eastern hemisphere, the Shaman or medicine-men of the North-American Indians generally envelop themselves in complete bearskins, which give them an awe-inspiring appearance.

#### Medicine-Men's Bags, Pouches and Drug Containers.

An important part of the paraphernalia of the African medicine-man is his bag or pouch, in which he carries his drugs and various oddments for use in his practice. Some of these bags are of large size, others, such as those used by the Kafir and Basuto witch doctors, are small and are more of a pouch



WITCH DOCTOR WITH DECORATED FEATHERED MASK.  
This shows the costume used by witch doctors of the Upper Transvaal  
and tribes akin to the Zulus  
(By permission of Wellcome Historical Museum.)

than a bag. They usually contain a strange assortment of objects, including the head-bones of antelopes, the claws of birds and bones of various animals which are used during the treatment of the patient. In Central and West Africa the medicine-man's bag is made of the skin of some animal peculiar to the district in which he lives, a special charm being believed to be connected with it. The skin of the polecat is frequently used for this purpose, the hairy side forming the exterior of the receptacle, and when the skins of birds are used the feathers are always put outside.

The medicine-men of the Loander negroes sometimes wrap up their drugs in pieces of red cloth decorated with small bells. In these they put various shells, nuts, small pebbles and the scrapings of certain horns which are held to be powerful remedies. The contents of some of the medicine-men's bags are varied and curious. An examination of some in the collection in the Wellcome Historical Medical Museum has revealed a varying and extraordinary assortment of objects.

The first is a bag formed from the pelt of a wild cat which measures thirty inches by six inches. Its contents consist of a necklace of blue and white glass beads, with one cowrie, a necklace of cowries and bean pods, some small horns filled with a sticky substance, a small cotton bag, a piece of hollow bamboo four and a half inches long, an empty matchbox labelled "Three Star Safety Matches, Made in Sweden," a fragment of bone hollowed out and apparently used as a container, another piece of bamboo six inches long, the metal portion of an old pocket-knife, a pod of *Cassia Fistula*, a metal ring two inches in diameter, three charms in the form of small bags made of material on a plaited string, a horn container with pieces of straw and string with shells attached, a tail of an animal, two small beans, a portion of the skin of an animal with brown fur, a bag of native cloth bound with a piece of twine, the head of a small bird, three pieces of the stem of a tree and the twigs of a shrub two and a half inches long.

Another bag of different shape is made of the pelt of a small animal and measures twelve inches long by seven inches wide. It has a flap to which are attached five primitive instruments, evidently used for surgical operations. One of these, with a sharp blade, is shaped like a scalpel, another has a curved blade, and there are also two straight instruments, probably used for extracting foreign bodies from a wound.

#### Ordeal Powders.

Another African medicine-man's bag of hide measures eleven and a half inches long by eleven inches wide. It contains five torpedo-shaped gourd bottles or calabashes decorated with skins and containing Kikuyea powder used as a remedy, a small calabash containing a powdered root used to promote vomiting after the ordeal ceremonies used by the medicine-man, and a hair switch used in the ceremonies.

A Kafir witch doctor's pouch measuring eleven inches by eight inches was found to contain an old knife with a bone handle and the blade half-ground down. It was probably used by the owner for surgical purposes. An interesting bag is one from West Africa. It is oblong in shape and made of soft skin eighteen inches long by six inches wide. The mouth of the bag, which is bottle-shaped, contains a bisected gourd into which is inserted a drum, and when the bag is compressed, concertina fashion, it emits a



AFRICAN MEDICINE BAG, SHOWING DAGGER AND CHARMS.

squeaking noise which the medicine-man assigns to the demon which he keeps inside the bag. It also contains some stones which rattle when the bag is shaken.

Another bag is made of the complete skin of a polecat, including the head and legs. It is twenty inches long and contains two horns filled with some solid substance used as a medicine, a pod containing seeds and a piece of bone wrapped in a very dirty piece of cloth tied with string.

#### Charms and Horoscopes.

The treatment employed by the medicine-men of the Somali and also in certain districts of East Africa

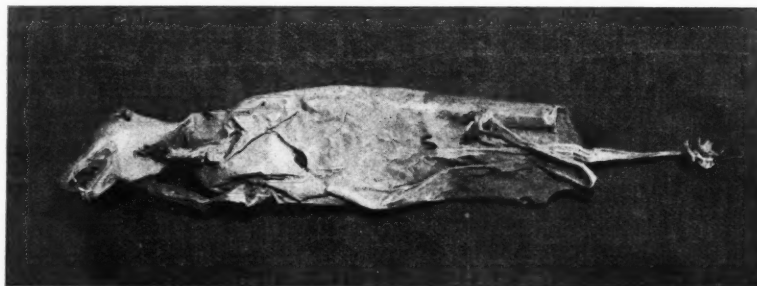
is largely mixed up with astrology and the sale of written charms and horoscopes. A bag used by a witch doctor in this region is made of cotton fabric originally of a buff colour stamped with a design of a small circle in black, and bound with a red material like braid, and contains a number of pieces of paper inscribed in Arabic, evidently used as charms, the lid of an Havana cigar-box, several pieces of old coloured fabric, a piece of wood of a pestle shape covered with fabric and bound with red braid, two pocket handkerchiefs of Indian calico with a blue border.

The materia medica of witch doctors includes the bark, roots, fruits and juices of various trees, shrubs and plants, also many animal substances, including human blood, the internal organs and secretions of animals and reptiles, which they regard as important remedies. Parts of the crocodile, in particular, are especially esteemed in some parts of Africa, and Sir David Bruce states that in Nyassaland nearly every part of the internal economy of the crocodile is valued by the natives for its remedial properties.

The knowledge of poisons, both animal and vegetable, possessed by the medicine-men and witch doctors

of Africa is considerable. The sources of those they employ for ordeal or for poisoning their darts or arrows, they guard with great secrecy. Naturally, the drugs they use are those peculiar to the regions in which they live. Thus the Malay jungle natives use the sap of the Upas tree which contains a powerful

poisonous principle. Certain tribes of South American Indians use curare, another virulent poison, which is extracted from a species of *Strychnos*. The *Bolantos* of West Africa employ Sassy bark, and other tribes



DRIED ANIMAL MEDICINE BAG  
from the Bunzoro tribe, Central Africa.

in this region use the Calabar bean, Kombe (*Strophanthus*) and others.

#### Useful Discoveries.

We owe the discovery of the last two drugs, the active principles of which have proved of such great value in modern medical practice, to native medicine-men. To the Shaman of North and South America we are also indebted for our knowledge of other valuable remedies such as the familiar Cascara Sagrada and the Cinchona (from which we obtain quinine) that was employed by South American tribes as a remedy for fever centuries before it was introduced into Europe.

#### EGYPT EXPLORATION SOCIETY.

THE Egypt Exploration Society will again be excavating at Tell el-'Amarnah under the direction of Mr. Newton. One of the most important pieces of work will be the completion of the clearance of the Northern Palace begun by Mr. Newton last season. Almost the whole of the southern half of this building still awaits excavation, including a large section of the domestic portion likely to prove of the highest interest. In addition to work on the palace, more excavation will be carried out in the small but imposing suburb of Akhetaten which lies even farther north.

Mr. Robert Mond is to continue his excavations in the private tombs of Thebes under the auspices of the University of Liverpool Institute of Archaeology. The work is threefold in character and comprises clearance, recording and preservation. At the moment

Mr. Mond's assistant, Mr. W. B. Emery, is engaged on the tomb of Ramose, a most important tomb, since it was decorated partly before and partly during the Aten heresy of Tell el-'Amarnah.

#### MAGNETIC FIELDS AND PHOSPHORESCENCE.

It is well known that many phosphorescent bodies when electrified emit a brighter light which usually fades rapidly. Recent experiments in Germany have shown that the same bodies respond only feebly to a magnetic as opposed to an electrical field, although the same phenomena are obtained. F. Schmidt attributes the effect to an alteration of the movement of the electrons and a rotation of the pairs of polarized atoms showing analogies with the well-known Zeeman effect.

## The Pigmentary Effector System.

By Julian Huxley.

*In this article-review of Dr. Hogben's book the author gives us an excellent illustration of the trend of modern research on response to gland secretions.*

It is interesting to the historian and encouraging to the research worker beset by baffling problems to see phenomenon after phenomenon which to earlier generations appeared inexplicable, dissolving into intelligibility before the advance of scientific analysis.

It is true that, in the past, workers who have been confronted with apparently inexplicable problems have sometimes been unscientific enough to declare that the problems did not really exist, and to write down as mysticism or charlatanism the statements of their opponents. The most noteworthy example of this "rationalization" of inexplicability was, of course, seen in regard to hypnotism; but there have been many other cases. Another slightly less extreme reaction is to try to explain, on already known grounds, problems which really demand as yet undiscovered principles for their explanation; this, as we shall see later, was the case in regard to the problem here attacked by Dr. Hogben.

No biological discovery of recent years has been more fruitful in throwing light on dark places than has the discovery of the endocrine glands and the effects of their secretions. It has cleared up a great many points in the working of the adult animal machine, and also in the mode of its development, which previously had baffled research. As an example of the former, we may take the facts concerning adrenalin, one of the secretions of the adrenal glands. This is usually released into the blood-stream at a constant and slow rate; but in case of emergency can be poured in quickly, and then appears to tune up the body in a particular way, making it ready to meet danger of struggle by violent action, by stimulating and sensitizing certain organs, while others are kept at subnormal level of activity. As an example of the second, we have the metamorphosis of animals such as the frog. How is it that all the complicated processes therein involved, the growth of limbs and skeleton, the loss of gills and tail, the change in the skin, etc., can all be synchronized so that all occur together at the right moment? The answer is this—that all the various tissues and organs involved are sensitive to the action of the thyroid's secretion, and that the process of metamorphosis is brought about

when a certain concentration of the secretion has been reached in the circulation.

Dr. Hogben has for some years been interesting himself in another puzzling problem—the problem of colour-change in animals. As often in physiology, the frog has proved an admirable *corpus vile* for experiment. As most people know, the frog is capable of great changes in colour and shade, from a brown which is almost black through brown-green to greenish-yellow. As a result of his work Dr. Hogben has clearly established that this colour change is brought about chiefly through the action of one of the secretions of the pituitary gland, at the base of the brain. This secretion acts upon the pigment cells in the skin, causing their contained pigment to spread through their branching arms, or to become condensed in a minute dot at the centre; in the former case the animal looks dark, in the latter light.

### Pituitary Gland.

The capacity of the frog to change colour according to the surroundings in which it is placed seems to depend upon the following sequence of events. The nerve-paths in the brain are so constructed that changes in the eye can affect the pituitary; and thus dark or light backgrounds can change the pituitary's activity, and cause it to secrete more or less than normal; and this in its turn will cause a greater or less expansion of the pigment cells and a difference in the frog's appearance. There are numerous minor details and qualifications into which there is here no space to enter, but the pituitary is the kernel of the problem.

Before the principle of internal secretion was recognized, reactions of animals to their surroundings were naturally first thought of in terms of nervous control—the only form of control then known which appeared adequate. The earlier history of research on the problem of colour-change in the frog is extremely instructive in this respect. Worker after worker set out with the conviction that it was all a matter of nervous control, that messages were sent direct to the individual pigment cells by individual nerve fibres from the brain or spinal cord; and what is more, they generally succeeded in finding evidence to support their view. Unfortunately, however, the evidence of different workers was entirely contra-

dictory! Dr. Hcgben gives reasons for much of this contradiction, showing how tampering with the nervous system might interfere directly with the pituitary, or might modify its effects by interfering with the circulation, etc. The whole history, as set forth here, is a most instructive example of how the average man can only find what he sets out to find, and of the extreme value of general ideas to the progress of science.

When we turn to other forms, we find that colour response need not always be effected in the same way as in the frog. In reptiles, for example, the evidence so far as it goes suggests that the adrenal secretion is the chief agent in controlling the pigment cells, while in fishes they are certainly under the direct control of the nervous system (although probably this control is abetted by internal secretions). Finally, in birds and mammals, although, of course, pigmented cells exist, no response of these to either internal secretion or nervous control occurs.

#### Endocrine Effect.

These facts illustrate certain important principles which are not always appreciated either by biologists or laymen. In the first place, hasty speculation, as revealed in the numerous semi-popular books on "glands," and also too often in medical and biological literature, is prone to assume that the effects of a gland and its secretion must always be the same wherever they are found to occur. This is not only unjustified, but incorrect. If it takes two to make a quarrel, so it takes two to make an endocrine effect—first the secretion of the gland in question, and then the power of some of the tissues of the body to respond to that secretion. Tissues which in one animal respond to thyroid, in another animal do not. For instance, in frog or toad tadpoles, thyroid causes the limbs to grow, the tail to disappear. In newt or salamander tadpoles, on the other hand, neither of these effects occur; although in both kinds of animals the gills, the skeleton and the brain are sensitive to the thyroid's action.

Even in one and the same animal at different periods of its career the same holds good. Once the frog tadpole has become a frog, its limbs no longer can respond to thyroid secretion.

This leads on to a rather different conception of the endocrine glands from the one which we might be tempted to adopt instinctively. There is gradually accumulating a great body of evidence which suggests that the bulk at least of the glands of internal secretion produce the same substance, or at least very closely allied substances, throughout the whole vertebrate series. Pituitary secretion from any vertebrate will cause the expansion of the frog's pigment cells as readily as the secretion of its own pituitary—even

pituitary secretion from an animal like a fowl or a rabbit in which the pituitary is powerless to effect colour change. In the same way, thyroid from any animal will accelerate the metamorphosis of tadpoles—even from animals like sheep in which there is no metamorphosis, or from creatures like *Necturus* in which no effects of the thyroid on growth or differentiation have yet been shown to exist at all.

Insulin and adrenalin are produced by all vertebrates too, and it is probable that other secretions are also similar or identical throughout the series.

In other words, the glands of internal secretion constitute what we may call a chemical ground-plan for the vertebrates, a ground-plan equally constant throughout the whole group as is the ground-plan of their structure as set forth in any textbook of comparative anatomy.

But the structural ground-plan may be modified in all sorts of ways to fit its possessor for different modes of life. The same plan is to be found in the fore-limbs of a whale, a man, a horse, a bird, a bat, a frog, a lion, although each subserves a wholly different function. So with the chemical plan. By varying the response-capacities of the various tissues, the same internal secretions can be made to perform wholly different functions in the life of different kinds of animals. Here, it seems to me, is a new principle of great general importance which has emerged as a result of the extension of research on the internal secretions from man and mammals to lower vertebrates.

As to the book before us,\* it certainly is welcome as a summary of recent research in a difficult and little-known field. If a criticism is to be made, it is to the effect that a rather broader treatment would have transformed the book from something rather slight and transient into a summary of more lasting value. We hope that our author will take the opportunity in a few years of issuing a second edition which will serve not only, as does the present volume, as a rapid survey of research and a signpost to future work, but as a general summary and textbook of all biological aspects of this interesting problem.

#### THE SCIENCE MUSEUM.

THE collections illustrating stationary engines and locomotives have now been transferred from the old galleries to the new ones on the ground floor of the eastern block of the new museum building at South Kensington (Exhibition Road).

\* *The Pigmentary Effector System*. By LANCELOT T. HOGBEN, D.Sc. (No. 1 of Biological Monographs and Manual. Edited by F. A. E. Crew and D. W. Cutler). (Oliver & Boyd, Edinburgh, 1924; pp. xii + 152, illustrated. 10s. 6d. net).

## English Paintings in the Middle Ages—II.

By Sir Frederic Kenyon, K.C.B., F.B.A.

*In the department of book illustration English painting from 700 to 1,400 was often the best in Europe. The Wars of the Roses and later the misguided energies of the Puritans were responsible for the destruction of much that was beautiful and for the break in our artistic tradition. Had the contemporary wall pictures and panel paintings been spared we could have pointed with pride to the evidence of a great artistic past.*

THE history of English painting has been brought down in my previous article to the Norman Conquest, the effects of which, on art as on literature, were profound and for the moment almost annihilating. The Winchester style comes to an end. The outline style appears to have survived, since we have a fine series of drawings for the life of St. Guthlac of Croyland, executed in the twelfth century, in a roll belonging to the Harley collection; but otherwise there is little evidence of it. In general, as was only to be expected, since the great landowners and patrons of the monasteries were now Normans, French work was predominant, and art in England is more closely linked than before not only with France but with Flanders and Germany. As the twelfth century progressed, a very fine school of calligraphy was developed, especially in the south-east of England, as at Canterbury, Rochester, St. Albans, and Bury St. Edmunds; and with this grew up a very rich style of decorative initials, similar in general character to the productions of artists in Belgium and Germany. The finest examples of this are great Bibles at Winchester (sadly mutilated) and Durham; but the Royal collection in the British Museum includes many fine volumes from which its character can be appreciated.

In the thirteenth century a fresh wave of influence reached England from France, which can perhaps be connected with the development of the University of Paris under the fostering influence of St. Louis. Certainly it is to this source that must be traced the great output of Bibles which marks this century. In place of Gospel books, written in large and handsome characters for church use, we have a multitude of complete Bibles, in small (often exceedingly minute) letters, which must have been intended for private ownership and use. These Bibles were illustrated with small illuminated initials, from which incipient borders began to creep along the margins of the pages. They were produced both in England and in France, but the style is identical. A particularly fine example is Royal MS. 1 D I in the British Museum; and here we know that the artist was English, William of Devon. The same style appears, on a rather larger scale, in

copies of the Psalms; and fine illuminated Psalters were produced in considerable numbers, both in England and in France, in the latter part of the thirteenth and earlier part of the fourteenth century.

Another special class of book produced during the same period is that of illuminated copies of the Book of Revelations. Whether they originated in England or in France is hard to say. Some of the earliest, and on the whole the finest, of the group are undoubtedly of English workmanship; but many were executed in France, and the style is so similar that it is often difficult to determine the country of origin. Perhaps the best of all these Apocalypses is that at Trinity College, Cambridge, produced probably at St. Albans about the year 1230; but other fine examples may be seen in the British Museum, the Bodleian Library at Oxford, and the Lambeth Library.

### The English Style.

So far, since the Norman Conquest, English art had been subject to French influence, and French and English work, in painting as in architecture, were very closely similar. Although we know that painting flourished in England in the thirteenth century, particularly at St. Albans under Walter of Colchester (who, with his brother Simon and his nephew Richard, executed paintings in the Abbey church) and the great historian Matthew Paris, of whose handiwork examples are still extant in the British Museum and elsewhere, it is only about the beginning of the fourteenth century, when English literature was beginning to raise its head again, when English architecture was breaking out into the efflorescence of its Decorated period, that a distinctively English style of painting once more asserted itself.

This time the centre of activity was in the east of England, in the great monasteries of Norfolk and Suffolk. While in France the development of the decorated border followed the lines laid down in the thirteenth century, the English artists struck out a line of their own. In France the borders which issued from the illuminated initial, spreading up and down the left-hand margin of the page, then turning the corners and pushing along the upper and lower sides, and finally meeting in the right-hand margin and

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PSALTER OF ROBERT DE LISLE. EAST ANGLIAN STYLE.  
14TH CENTURY.

so enclosing the column of writing in a complete frame, remained narrow, with firm graceful curves and delicate finials, and occasional slender tendrils of foliage. At a later period this foliage was destined to expand into the well-known ivy pattern, which in the fifteenth century tends to become mechanical and tedious; but in the fourteenth century, and especially in the early part of it, it is a style of great beauty and artistic delicacy. The borders are enlivened at times by little figures of birds or grotesques of men and animals, of a delightful charm and animation, showing that the painter had humour and felt the joy of artistic creation. At the same time there is a sense of restraint, often more attractive than the superfluity of gorgeousness which marks the later periods.

In the East Anglian school the border blossomed more freely, and the elements of which it was composed were rather different. The initial letters were larger and more elaborate, the borders broader and of a more

complex outline. While a French page of the early fourteenth century excels in grace and delicacy, an East Anglian page excels in richness and luxuriance. At this period both countries were happy in the possession of an artistic style of the highest excellence, different in character but equally delightful. While France can show such gems as the Life of St. Denis at Paris, or the Sainte Abbaye in the British Museum, England has no reason to shrink from the comparison when it can produce such volumes as the Gorleston Psalter of Mr. Perrins, the Ormesby Psalter of the Bodleian, the St. Omer Psalter, recently presented by Mr. Yates Thompson to the British Museum, the "Windmill" Psalter in Mr. Pierpont Morgan's library, the Peterborough Psalter at Brussels, and the De Lisle Psalter (Arundel MS. 83) in the British Museum.

It will be observed that all these great volumes are Psalters; and whereas in the earliest days it was the Gospels that usually attracted the best labour of the



BIBLE EXECUTED AT CANTERBURY BY WILLIAM OF DEVON,  
13TH CENTURY

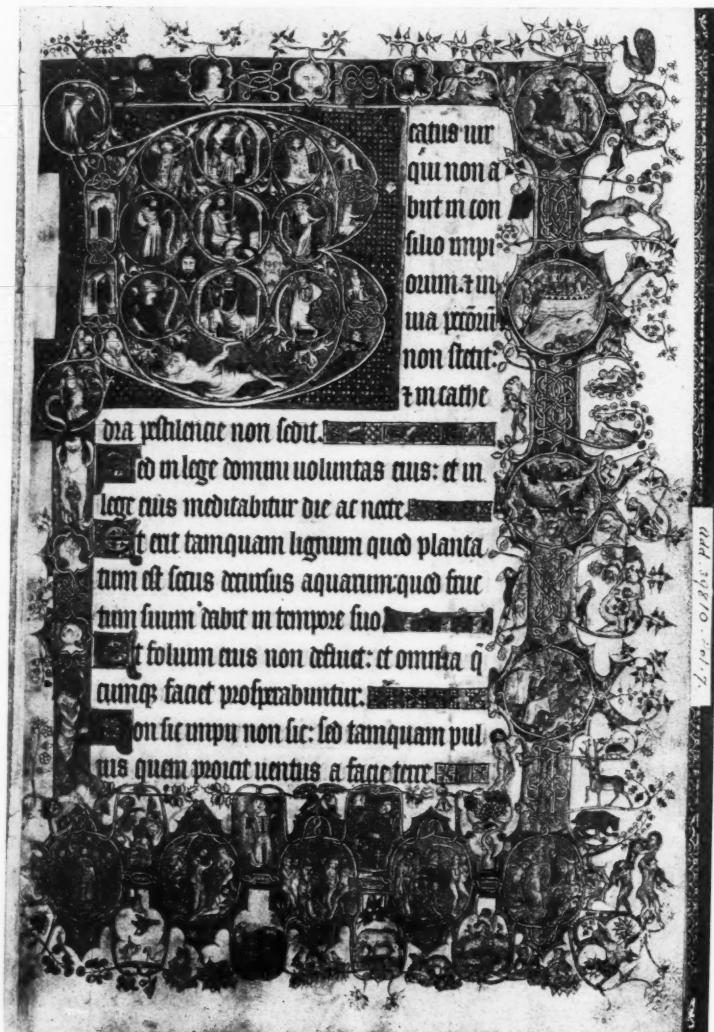
illuminator, and in the thirteenth century the Apocalypse, in the fourteenth the book of Psalms, which had not been neglected before, seems to have blossomed into especial favour. Besides the group of East Anglian Psalters already mentioned, we have, in a style more closely connected with that of the French school, the Tenison Psalter, executed about 1282, the Grandison Psalter about the end of the thirteenth century, the Psalter of Philippa of Hainault, Edward the Third's queen (before 1340), the Rutland Psalter of about the same date, and not a few others. To these must be added the well-known Louterell Psalter, in a style of its own, full of large and boldly - coloured grotesques and representations of everyday life; and, last and most beautiful of all, the exquisite volume known as Queen Mary's Psalter.

This wonderful book, which owes its title to the fact that it was seized by a zealous custom-house officer at Dover when in the act of being sent out of the country, and was offered by him to the then reigning sovereign, Queen Mary, and which eventually passed with the rest of the Royal Library to the British Museum, has some right to be considered the most beautiful product of the English mediaeval school of painting. Its place of origin is unknown, but its English

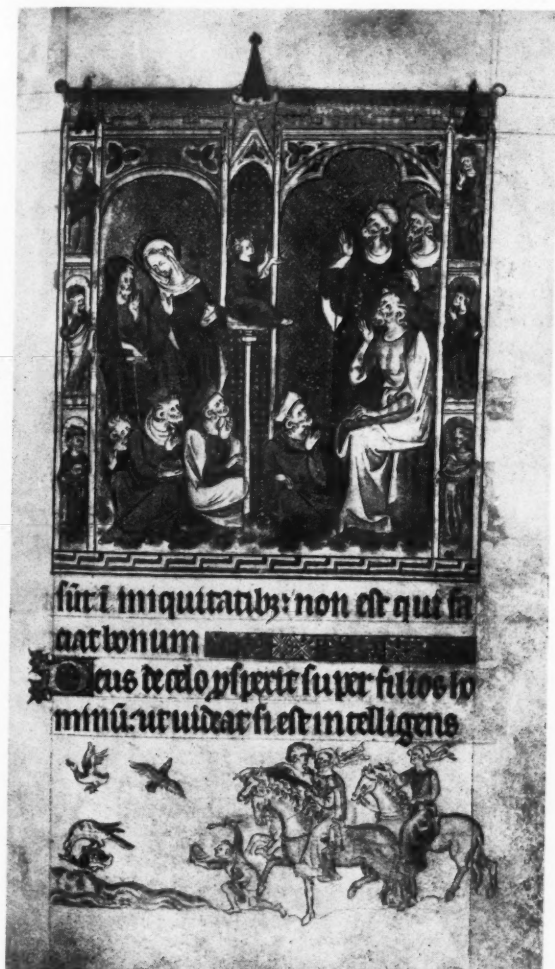
character is unquestionable. In date it must belong to the reign of Edward II, and it may have been executed for his court. The text of the Psalter is preceded by a long series of illustrations of the book of Genesis, two to a page, executed in the most delicate style of

outline drawing, very lightly tinted, generally with pale green. These drawings, and the marginal illustrations in similar style which adorn every page of the volume, represent the climax of that outline style which we saw firmly rooted in England in the tenth and eleventh centuries. Here all its grotesquenesses and occasional awkwardnesses are purged away, and the drawing is of an incomparable delicacy and grace. A country which could produce a volume showing such richness of invention, such skill of hand, and such a refined sense of beauty, must have been capable of panel or mural painting which would have held its own with any on the Continent.

A break occurs in the development of English painting about the middle of the fourteenth century, caused possibly by the French wars of Edward III, but perhaps more probably by the social upheaval of the Black Death in 1348-9. The spirit of art, however, was not extinguished; and about the time when English architecture was finally cutting itself



PSALTER OF THE FAMILY OF ST. OMER. EAST ANGLIAN STYLE, ABOUT 1330.



QUEEN MARY'S PSALTER. EARLY 14TH CENTURY.

adrift from its continental associations, and forming its characteristic Perpendicular style, English painting put forth its last original effort in the school of illumination which flourished in the time of Richard II and his successor. In origin this school seems to have owed something to Bohemia, from which country artists may have come to England in the train of Richard's wife; but its development was indigenous, and its excellences are its own. It excels in large initial letters, whether historiated (*i.e.*, containing figure subjects) or composed of decorative patterns. Its borders are rich in foliage, chiefly composed of trumpet- or spoon-shaped flowers. Clumps of very dark-leaved trees are characteristic of the marginal paintings of some of these manuscripts.

This late fourteenth-century school is represented in the British Museum by two magnificent volumes

which appear to have been executed for the royal chapel. One of these, a huge Bible, survives in all its original splendour. The other, a missal, has been the victim of a cruel fate. Some previous owner (probably in the early part of the nineteenth century) conceived the unhappy (indeed almost criminal) idea of cutting out all the illuminated initials and pasting them down in an album, grouped by sizes in patterns, after the fashion of a child who collects crests. It is difficult to appreciate the frame of mind of the person who would take the trouble involved in this work of desecration, and yet could not realize how infinitely more beautiful the original volume was than his mechanical patterns formed out of its mutilated remains. The volume as a whole has perished, but the *disjecta membra*, especially when taken in conjunction with the complete fellow-volume, are proof of a highly accomplished artist, with a fine decorative sense and great powers of execution, both in figure-drawing (there is a charming little portrait of Richard II) and in ornamental pattern.

Another admirable product of the same school is the



BEAUFORT BOOK OF HOURS. ABOUT 1400.

Book of Hours executed quite at the beginning of the fifteenth century for John de Beaufort, Earl of Somerset, and Margaret his wife (Royal MS. 2 A xviii). But the supreme achievement of this period, and one of the prime glories of English art throughout the whole of the Middle Ages, is the Sherborne Missal, executed about 1396-1407 in the south of England, which for the last two centuries has been the property of the Dukes of Northumberland—or, may we not say (since they received it as a gift and have regarded it as an heirloom), of which they have for that period been trustees for the nation? In the case of this magnificent volume (one of the largest, as well as one of the finest, in existence), contrary to all custom, we know the actual names of the scribe and artist responsible for its production. Their portraits and names—John Was and John Siferwas—occur repeatedly throughout the volume; both names are known elsewhere in English documents of the period, and the former, in the form of Wass, has continued in use to the present day.

#### Self Portrait.

The individuality shown in this repeated presentation of the name of the artist—of whom a larger self-portrait is preserved in a fragmentary manuscript in the British Museum, where he is shown as a tonsured Dominican of genial presence, offering his book to his patron, John, Lord Lovel of Tichmarsh—is reflected in his style. No work in the whole record of English illumination is so strongly individual in character. It exhibits some of the characteristics of the style of the period, such as the trumpet-shaped flowers and the dark masses of tree-foliage, but in other respects is unlike the work of any other illuminator. Elaborate architectural canopies are a common feature in his borders; he is fond of winged angels with delicately-tinted pinions; and he was evidently a great lover and careful observer of birds, though an altogether wonderful series of pictures of birds on a large scale, with their English names attached, is perhaps due to another artist. Curiously enough, the finest production of the later French school, the *Tres Riches Heures* of the Duc de Berri, produced a little later (about 1416) by Pol de Limbourg and his two brothers, is also the most individual work of French illuminators; and in both cases little, if any, other work of the same accomplished artists has come down to us.

With John Siferwas and the Sherborne Missal we reach the climax, and almost the end, of the English school of mediaeval illumination. A few other fine volumes were produced in the early years of the fifteenth century, though none approaching the magnificence of those which have been mentioned; and after the close of the reign of Henry IV the style

declined rapidly. The wars of Henry V, and the occupation of a large part of France which followed the battle of Agincourt, carried many of the great English nobles into France, and brought them into contact with French illumination, then at the height of its splendour. In particular, the Duke of Bedford, Regent in France after the death of his brother King Henry, had the opportunity of making use of the great school of artists employed by Jean, Duc de Berri; and to this we owe the splendid Bedford Book of Hours, which is the finest example of French illumination in the British Museum. The exhausting French war was followed by the still more destructive Wars of the Roses at home; and in this cataclysm English painting, as applied to the decoration of books, went down for ever. French illumination continued, with almost equal richness and elaboration, though with less delicacy and invention, well into the sixteenth century; the Flemish school, with its delightful *genre* pictures and its borders with minutely represented forms of insect life and flowers, had its short period of mastery; and Italy developed a school of decoration of unparalleled richness of colour and elaboration of border design. But native English painting, ruined by the causes already mentioned and not encouraged to revive by the Puritan spirit of the Reformation, disappeared, not to revive until the eighteenth century.

We return to the proposition with which we started. If English painting could so often in the seven hundred years from 700 to 1400 be the best in Europe in the department of book-illustration, it is hardly permissible to doubt that it held an equally high position when applied to mural painting or panel pictures. But for the destructive zeal of the Puritans, the evidence of English artistic genius would have been not less plentiful in painting than in architecture; and England would have had behind it an artistic tradition which would have made foreign depreciation impossible, and might have inspired modern English artists with the self-confidence which rests upon the foundation of a great past.

#### ENTOMOLOGICAL SOCIETY OF LONDON.

MEETINGS of the Entomological Society of London, 41 Queen's Gate, S.W.7, are as follows:—

Wednesday, 14th January, 1925 (Annual Meeting);  
Wednesday, 4th February.

The chair will be taken at eight o'clock in the evening precisely.

The Library is open daily from ten a.m. to six p.m. (except on Saturdays, when it is closed at one p.m.), and until ten p.m. on meeting nights. It is also closed in September.

## Spalax: a little-known European Mammal.

By Ivor Montagu.

*The writer while on a collecting trip for the British Museum investigated the habits and burrows of this remarkable animal. He has since returned to Central Europe and hopes to be able to bring back a live Spalax for the Zoological Gardens.*

HÓDMEZOVÁSÁRHELY is a difficult name to remember; its pronunciation, clipped in the birdlike twittering speech of the Hungarians, is different from its spelling. In search of the whereabouts of *Spalax*, I flew from Vienna to Budapest; at the National Museum I heard of the town where six specimens had been taken in one year, so there I went.

Inquiries the next morning showed that the animal was familiar by name, *földi kutyá*, earth-hound, to most of the inhabitants of Hódmezovásárhely.

The farmers all know of it; those whose lands lie to the east of the town often cut across its burrows with the plough, or in digging, and sometimes turn it up from a chance shallow tunnel. Four of the reported specimens had been caught: thus by accident. The other two had been intentionally dug out, a proceeding which requires two or three weeks' hard spade-work.

### Underground Mammals.

Bancroft Clark and the writer spent three days excavating burrows, beginning each morning for fear of the sun which, though summer was just finished, still burnt the cultivated treeless plain. Nothing was caught, but burrow maps and casts were made. It was in the course of this work that much of the bio-nomics that follows was confirmed or acquired.

When one thinks of an underground animal, one naturally thinks of *Talpa*, the mole. Many British animals make dwelling-places underground: the rabbit, the water-rat, most of the wild mice, the fox, the badger and so forth. All these, in greater or less degree, are capable of burrowing. They have the necessary strength, which implies a certain muscular specialization, and the appropriate tools, which implies a certain specialization of their appendages. But only the mole spends its whole life underground.

All the other burrowers come out so regularly in search of food, and, indeed, to carry out all their activities except sleeping and parturition, that they can easily be caught on the surface in traps or snares, and are objects known by sight to persons walking in the country. But while the mole does leave its burrow on occasion, as many records relate, its sorties are so infrequent that no one intending to catch a specimen would set traps on the surface. The mole finds its food, the larvae, beetles and worms encountered in the course of tunnelling, always in the ground itself.

Its characteristics are adapted to this form of existence. It has a roundly cylindrical body in which the external legs have so nearly disappeared that the feet are nearly flush with the body.

### Lost Tail.

The tail is reduced, short and club-shaped. The external ear has completely disappeared, and the eye is also reduced, and not seldom completely covered with skin.



A SPALAX-RAVAGED FARMSTEAD IN CENTRAL EUROPE

An appearance so specialized for underground life is found typically in four groups: *Talpa*, *Chrysochloris*, *Notoryctes* and *Spalax*. *Talpa* and related forms of the insectivore family *Talpidae* spread over the temperate part of the Holarctic region, and even elsewhere. In England they may reach as much as 140 mm. in head and body length. *Chrysochloris*, the Cape Golden Mole of South Africa, also an insectivore, is subequal to *Talpa* in size, but other genera of its family, specialized like itself, and likewise found in Africa, may be much larger. *Notoryctes* is the rare marsupial mole, of course, an Australian; it is also much the same size as *Talpa*.

*Spalax* is a rodent, usually more than 300 mm. in length. Its range extends from Egypt and Palestine to South Russia. In Europe it is found in parts of

the Balkans, Hungary, and Transsylvania. It is quite exceptional among its relations, for other spalacid genera are in no way so fitted for underground life. These three latter groups are also cylindrical, and with inserted legs.

The burrow systems of animals which, like rabbits, most field-mice, and so forth, forage for their food in an area of relatively wide radius, consist only of sleeping chambers and passages giving access to them. Those animals, marmots and gophers, which rarely or never leave an area delimited by a short radius from their burrow's mouth, usually inhabit systems including dung chambers and food stores, as well as sleeping places. True subterranean animals, since all their activities take place underground, live in great complex structures with several different kinds of chambers and long intercommunicating passages. Those of the mole are well known, and have often been described. Those of *Spalax* vary probably according to the nature of the soil. In Egyptian sand they are branched, involved, and complicated, for the medium is an easy one. In the hard soil of the plain of Hungary each tunnel seems built with much more care and permanence.

#### Habitat.

In this part of the world, where agriculture is the fruitful characteristic livelihood of the inhabitants, vegetable gardens abound, and in such are commonly found *Spalax* tunnel systems. A field of this kind contains a host of different plants: melons, maize, sunflowers, tomatoes, paprika, pumpkins, cucumbers, onions, beans, potatoes, radishes, carrots, parsnips. Many of these, certainly those with succulent underground parts, form the food of *Spalax*, whose depredations therefore make him an animal disliked by the farmers. It is said that in the Middle Ages, Latin denunciations of him, inspired by his food-habit, were misinterpreted by English monks as referring to the mole, and that this is the true source of the undeserved bad odour in which the mole is held by English farmers. Here and there, in a line of root crops such as parsnips, may be noticed three or four plants, perished and withered in appearance. These pull quite easily from the soil, for their roots are gone, gnawed away, and carried off or eaten. Pulled up, they expose a tunnel which passes them and can be followed by the hunter in either direction. Though

the burrow system may extend from this ravaged point for a hundred and fifty yards or more, there is quite likely no other sign, externally visible, of its presence.

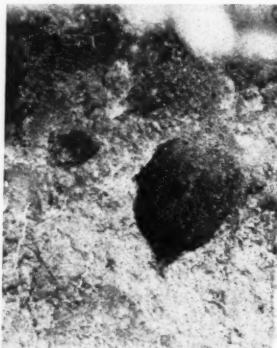
There is no trace anywhere of excavated earth, nor anywhere a sign of access to the surface. It has been said that *Spalax* sometimes leaves its burrow to feed on surface-growing vegetables, and the nest bedding is grass that certainly is obtained from above; but when the animal returns from such a sally the hole through which it went is immediately stopped up and obscured.

From the eaten plants extend some twenty or thirty yards of branched cylindrical twisting tunnels, about four inches wide, with their roof some two or three inches below the surface. The hunter is at a loss; the burrow seems all exposed, the beast not there. But the end of each apparently blind tube must now be dug away; at least one of them will be found continued behind an earthen barrier six to eight inches thick.

#### Twin System.

These branching tunnels are simply runs made in search of food, and are cut off by the barriers from the true dwelling burrows. On the other side of the barrier the inhabited burrow runs often in several directions. It winds about, but it is distinguishable from the exploratory food tunnels in that it is not branched for the first thirty or forty yards.

The tubes begin to run deeper, and to branch, sometimes running under each other, sometimes leading to or forming chambers. Some such recesses are food stores, containing bulbs or roots. Some, with hard floors, are said to be water reservoirs. In others is deposited the dung, which is never seen elsewhere soiling the tunnel system. The sleeping chambers are large, about six inches high, and in shape nearly circular of a twelve-inch diameter. They may be a foot or more below the surface—yet more, it is said, in winter. Each is loosely filled with dry bedding, consisting of grasses and the outer shredded leaves of onion. To expose the whole extent, to determine the number of such chambers and the aggregate length in a single system, is nearly impossible. In the first place the number of entrant branches missed by the hunter in his exposure of the main tube is probably considerable. These branches are often concealed by barriers; and absolute certainty that no block is left unpierced is difficult, especially at great depths,



Excavations showing a nest cavity with a small second chamber within it. On the right a second tunnel descending forty inches into the soil.

in the hard soil. Nor can it always be guessed whether a stop, when detected, is a barrier between two separate *Spalaxes*, or separates an inhabited from a since-vacated tube, or is merely an obstacle regularly set aside by the animal, but put up to the confusion of dog or wild predatory carnivore. Furthermore, even the continuous unstoppered tubes of the system are not always easy to follow. Of one system excavated by Bancroft Clark and the writer, four ends were left untraced to their finish: two, after they had been followed for nine yards, twenty inches below the bottom of a ha-ha five feet deep; and two, followed only for five yards, forty and fifty inches deep respectively and running ever deeper.

#### Digging Methods.

To accomplish structures of this thoroughness, size, and depth, it is clear that the burrowing mechanisms of *Spalax* are highly specialized and efficient. The mole (*Talpa*) has front feet hard and broad and spadelike. With these it digs the soil and lifts it clear out of the burrow in the familiar form of molehills; it probably uses them also to press and make the burrow walls, giving them permanence. Many small rodents use their feet in the same way, though, since their burrows are less complex, the appendages are less specialized. An example is the prairie dog, which also throws out a hillock from its simple tube. But *Spalax* does not work in this way; its small weak feet would be incapable of such a performance. It pares away the soil with its teeth, and compresses the loosened earth into the tube wall with its padded horn-tipped nose. Dints made by the terrific thrusts of this pad are an omnipresent and characteristic mark in the burrow systems. By the nose the earth of the wall is so tightly packed as to become of close, even seemingly impermeable and infinitely lasting substance. Tremendous pressure must be exercised by the animal in performing this process, especially at great depths. Only in two kinds of circumstances are the nosemarks less conspicuous. Occasionally they are obscured where the tube bore is exceptionally narrow, and

constant passage of the animal has brushed flat its sides. The nosemark is also rare in tunnels such as those described as being on the side of the barrier near the gnawed radishes. Here the *Spalax*, since the tubes are not to be part of his dwelling system, takes little care in shoring up the walls; even toothmarks remain, not having been worked over with the nose. These toothmarks, being double, and the trace of a divaricated pair of teeth, are identifiable as those of the lower incisors. This indicates that, in *Spalax* as in other rodents, these teeth are the active agents in gnawing. The degree to which they are specialized in

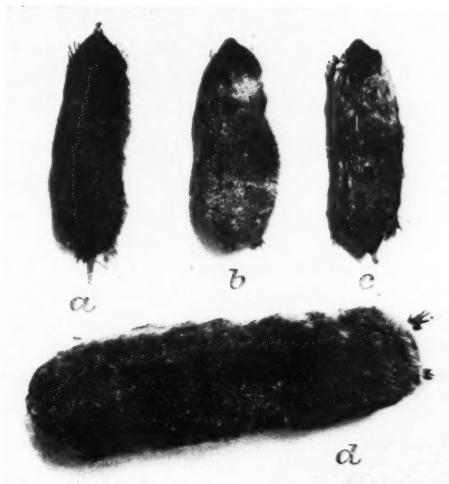
*Spalax* is shown by the following morphological note:—

$$\frac{\text{The length of lower incisors exposed from bone}}{\text{The length of upper incisors exposed from bone}} \gg 2$$

This ratio is much less in nearly every allied rodent. So far as I am aware, evidences of the burrowing methods of *Chrysochloris* and *Notoryctes* have yet to be collected; but it may be inferred on morphological grounds that, in these phylogenetically far-distant genera, the burrowing method is substantially that of *Spalax*. In both forms a hardened nose-cap, yet more conspicuous than that of *Spalax*, is present. In each form the functions of the divaricated lower incisors of *Spalax* can

be performed by the two great cutting toes which alone remain functional on each forefoot. And in *Notoryctes* the hind feet are also modified for digging, and the tail has become a curious organ mounted also with a horny pad. *Spalax* has been described as running indifferently forwards and backwards in its burrows, for their bore is usually too narrow to allow it to turn. Probably *Notoryctes* can run both ways in a similar manner, and, moreover, can dig effectively with either end.

SIR JAMES MACKENZIE, M.D., F.R.S., LL.D., Physician to the King in Scotland, has been awarded the Charles Mickle Fellowship Prize by the University of Toronto in recognition of his distinguished work in medical science and medicine.



a. TALPA. THE MOLE.  
b. CHRYSOCHLORIS. THE GOLDEN MOLE.  
c. NOTORYCTES. THE MARSUPIAL MOLE.  
d. SPALAX.

## A Seventeenth-century Cat-burglar.

By Kenneth Hare.

*The cat-burglar is the latest novelty among our modern criminals. Here you will find his ancestor a thief who dropped down chimneys and when challenged depended on his wit in place of a stolen motor car.*

THERE is abundant evidence to prove that the gentleman highwayman of the type immortalized by Gay in "Polly" and the "Beggar's Opera," had his counterpart in real life. "Jemmy" MacClean—who robbed the old Earl of Eglintoun of the blunderbuss with which he had proposed to defend his coach and person—was a member of "Button's," the coffee-house patronized by Dean Swift and Pope the poet. Duval's popularity with women was due not only to his being what was called "a pretty fellow," but in great measure also to fine manners and address. Jackson, hanged in 1674, gives the near date of his approaching execution as his reason for not rewriting his confessions, and apologizes to the reader for the enforced deficiencies of his prose-style!

But Joseph Sadler was none of your high-brow bandits, neither was he a fine gentleman. The principles implied in the phrase "noblesse oblige" were such as he may be pardoned for not having taken more deeply to heart, for his birth, so Sir Roger Lestrangle informs us, was "so obscure that we are beholding to natural philosophy to know that ever he had a father." Nor could the niceties of English prose affect his tranquility, for he was as innocent of the alphabet as he was of Homer.

And yet he had a style, there was a *manner* about the rogue, he committed his depredations with an *air*. He stole the beaver hat of a gentleman whom he observed praying in the Temple Church, and pleaded in extenuation that we are enjoined "to watch as well as pray."

He was as cowardly as Shakespeare's Autolycus, and like him, prone to improve a situation. Having robbed an apple woman of four pounds—her day's takings at Covent Garden—he produced a coil of rope and proceeded to make her secure. He tied her to a gibbet on which a malefactor was hanging in chains, observing politely, "I would not leave a lady without company when night is coming on." A discreditable job—but done in the Sadler manner!

In his youth our adventurer had been a bricklayer, a calling which he followed with probity if without enthusiasm. A romantic passion caused him to change his mode of life. Love, despite romancers, does not invariably inspire to high idealism and heroic endeavour. The young lady was fair, but she was

likewise a pickpocket, and she persuaded Romeo to adopt her own profession, to augment his salary and maintain her in the luxury to which she had been accustomed.

His lack of physical courage was more than compensated for by his ready wit. Of this, the following example will serve as well as another. He let himself down into a rich citizen's house by way of the chimney, but here all analogy with Santa Claus ends, for he found so much more to take away than ever he brought with him, that to ascend proved a feat beyond his powers. He tiptoed downstairs into the hall, but his cautious testing of the front door produced disconcerting results. "The whole house rang with the lamentable cry, 'Thieves! Thieves!'"

### Presence of Mind.

Clearly there was no time to be lost. He marched upstairs again, but heard footsteps approaching from all quarters. Catching a sheet from a chest of drawers, he draped himself with it after the best manner of the turnip ghost and, opening a door, marched almost into the arms of the master of the house who, with a drawn cutlass in his right hand and a cocked pistol in his left, stood prepared to give the interloper a warm reception. Sadler was equal to the occasion. He bent upon the householder one stony regard, and the poor wretch threw away his weapons, dropped upon his knees, and fell to prayers. The sprite stalked with dignity to the window, opened it, knotted a corner of the sheet to the balcony railings, slid down in the dark, and rushed off with the booty. What an actor the fellow must have been!

Here is another example of his extreme ingenuity. He determined to obtain some plate from a goldsmith's window, and thus he set about it. Dressing himself out in his finest array, he paid a call upon a fashionable physician who specialized in lunacy, desiring him to examine a young relation of his who had become mentally unbalanced. He proceeded to symptoms. Sadler's young relation, though exceptionally well-to-do, had taken to dressing not according to his rank, but meanly—you might take him for a 'prentice boy. Avarice, Sadler opined, was the root of the trouble. The sufferer had much valuable plate which he was in dread of having stolen, and he was forever demanding of all whom he encountered if they had not had it.



THE ROGUE'S PROCESSION THROUGH LINCOLN'S INN FIELDS.

*[From a later drawing]*

The doctor undertook the case and a fee of twenty guineas was agreed to, payable upon cure. But at this juncture Sadler raised a further difficulty. The young kinsman was a bore, a terrible bore if the truth must be told, and Sadler never knew how to be quit of his company. Might he leave the patient a moment at the front door, and make his own escape some other way? He might? By the back door? The doctor was too good! These preliminaries adjusted, and the hour for the appointment being agreed upon for that morning, away walked Sadler at a good swinging pace towards the goldsmith's shop.

He entered, made a remark or two about the weather, and introduced himself as the best friend of the dear old doctor—whose credit, as he had previously ascertained, was excellent. The dear old doctor desired to set up a cupboard of plate, but was too busy to step round in person, you know. He had given Sadler "carte blanche" to choose the platters and goblets for him. Having made a liberal selection, he requested that the goldsmith's 'prentice might be sent round with it, and he promised himself to accompany the lad lest the possession of goods of such value might incite him to some dishonest action.

All was working out beyond expectations. The goldsmith agreed to this wise precaution and away went the pair to the doctor's house where they arrived at the hour of the appointment—Sadler carrying the parcel that contained the plate. He rapped at the great polished knocker, entered first, entreated the physician to neglect no pains to ameliorate the unhappy lad's condition, and then took his departure, as arranged, by the back door.

Having obsequiously ushered him out the man of science returned to survey and take stock of the patient. He would not use force at first. He adopted

his best bedside manner, and in a tone of blandishment he cried, "Come in, Sweetheart,"—a term then equally applicable to both sexes—"Come in!"

"Have you had the pla.e, Master?" asked the luckless youth. A sinister beginning, and one which confirmed the doctor's worst fears. And yet what else could he have said? Sadler had been carrying the costly parcel and Sadler had vanished.

#### **Crowning Episode.**

But this solicitude with regard to the plate, which the doctor, of course, had never seen, exactly corroborated the version which Sadler had given of his "kinsman's" symptoms. The personal slovenliness, which likewise Sadler had foretold, was no less apparent. This rich young fellow, so far from vying with the brilliant Sadler in splendour of apparel, looked for all the world like a 'prentice to some tradesman. In those merry old days the tactics of even fashionable doctors when confronted with lunatics were hearty and bluff. The physician summoned to his aid two burly footmen and, discarding the bedside manner, fell upon "Sweetheart," bound him stoutly with cords, deposited him in a dark room, and bled him.

And Sadler? One pictures him striding off with much apparent ease of manner. A ballad air trolls lightly from his lips, "Love's a Sweet Passion," or perhaps, "Fond Boy."

Many were the frolicsome frauds perpetrated by this English Ulenspiegel. His crowning achievement was his theft of the Purse and Mace of the Lord High Chancellor of England. How he discovered in what strong room they were secured never transpired, but he not only had these baubles from their lurking-place, but marched with them, publicly displayed, through Lincoln's Inn Fields. One confederate bore the Purse

before him, the other the Mace, and Sadler brought up the rear, hat cocked and arms akimbo, with an "insolent and strutting grandeur."

The theft was discovered by the little daughter of Sadler's landlady. She was playing in his apartment during the great housebreaker's absence when she discovered a pearl and a piece of tinsel upon the carpet. Anxious to know if there were any more of these pretty playthings concealed about the room, she succeeded in prizing open the cupboard door, and her surprise wellnigh equalled that of Bluebeard's wife when she peeped into the famous Blue Closet. "Mother! mother! come up here!" cried the child, "The gentleman has his Majesty's crown!" What she beheld in point of fact was the coronet of the mace detached from its stock. The landlady warned the watch and an ambush was laid.

#### Tame Ending.

Sadler's physical courage was never above proof. No wounds were given or received, no horses shot under him. Hoping by mild behaviour to mollify his judges, he simply "gave himself away gratis," like Sir John Colville in the play. Loud was the laughter when the facts became known and when Sadler confessed to having figured as the Lord High Chancellor in that extraordinary harlequinade in Lincoln's Inn Fields. Loud was the laughter, but poor Sadler was condemned to death in sober earnest. It is hard for a jester to be taken quite so seriously. On hearing the decision of the court he flung his hat one way, his wig another, and behaved like one utterly beside his five wits. How he must have cursed in his heart the false Delilah who first lured him from the fatigues of honest bricklaying!

In Newgate, however, he plucked up heart again, and grew to be tolerably at home, and if familiarity could ever have bred contempt of that forbidding old pile it must have done so in Sadler's case, for he had been there fourteen times before! In prison he "betook himself mightily to drinking of sack"—a solace which in our day would have been denied him.

The last glimpse we have of him shows his humour to have been ingrained, to have endured wind and weather, but one must visualize the scene to relish the joke. Those were the days when society was a caste, and a certain halo of mystery and removedness still clung about the great nobleman. A peer held levees when all sorts of folk would solicit his patronage and when he would deal with requests, begging letters, petitions, and the like.

A turnkey entering his cell informed Sadler that the chaplain was waiting outside and desired to pray

with him. Our rogue, affecting to regard the turnkey as an importunate lackey, motioned him back and, clapping his rummer of sack in his horny hand and mimicking the haughty languor of some weary magnifico, observed drily, "The parson must wait till I have drunk my glass out."

What figure would Sadler have cut had he been born in the twentieth century? He would have received at least the elements of education. Would he have composed a picaresque novel, a melodrama, detective stories? Would he have shone as a cinema-star or have appeared "on the halls" in the role of mimic, or backchat comedian? Or again, would he just have been to-day what he was in his own day, a humorous rogue? The last, let us hope. Our criminals of late have been sadly deficient in vivacity and the lighter graces.

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#### QUEKETT MICROSCOPICAL CLUB.

MEETINGS of the Quekett Microscopical Club for 1925 at 11 Chandos Street, Cavendish Square, W.1, on the second and fourth Tuesdays of every month:

		Ordinary 7-30 p.m.		Conversational 7-9.30 p.m.
1925 Tuesday, January	...	13	...	27
" " February	...	*10	...	24
" " March	...	10	...	24
" " April	...	14	...	28

\* Annual General Meeting.

Hon. Secretary Excursions Sub-Committee, F. E. Cocks,  
131 Willifield Way, Golders Green, N.W.11.

#### HASTENING THE COLORATION OF LEMONS.

LEMONS when picked are usually green although ripe enough for sale, and to produce the usual yellow colour rapidly they are placed in rooms heated by the fumes from paraffin stoves; these give off a gaseous chemical compound, ethylene, which, at a concentration of 1 in 200,000, colours the lemons in five to eight days. This has no harmful effects upon the fruit or the eater.

## Sugar made in the Laboratory.

By T. W. Jones, B.Sc.

*For many years research chemists have been striving to make sugar. At last Professor Baly has succeeded and his success opens the way to extremely important developments. At present the process is in the experimental stage, but later simpler and cheaper methods may be found. The discovery may be one of the first steps toward the production of synthetic food-stuffs.*

SUGAR has been synthesized in the laboratory.

Entirely artificial means were used. There was no growing of plants, or fermenting of yeasts; it was done simply by allowing artificial ultra-violet light to play upon a stream of bubbles of carbonic acid gas ascending through distilled water—that is to say, by photo-chemical means only.

Professor E. C. C. Baly, of Liverpool University, by using these means instead of the natural ones used by the plants, has been able to synthesize sugars in a similar way to that by which plants convert the carbonic acid gas of the atmosphere into sugars and starches under the influence of sunlight. We say a similar way for the very good reason that the exact mechanism of the plants' chemical and physiological action is still unknown, and we have so far only been able to form theories that, though they explain the facts very well, may nevertheless be quite at fault.

Some time ago Professor Baly noticed that if ultra-violet light from quartz mercury vapour lamps (the same lamps that are used in cinematograph studios) were allowed to fall upon a stream of carbon dioxide bubbles (carbonic acid gas) rising through distilled water in a quartz test-tube, a certain amount of formaldehyde (the well-known disinfectant gas) was formed, and that this then polymerized (the molecules joined themselves together into clumps) to form sugars.

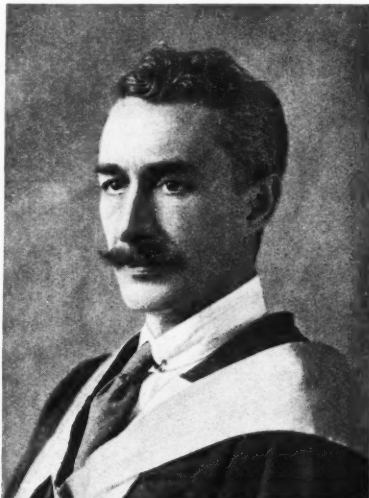
### Wave-length Effect.

The amount of sugars formed in this way was very small indeed, and their presence could only be detected by very delicate chemical tests. To increase this quantity to anything like useful proportions proved a difficult task, because the ultra-violet light given off by the lamps contained light of differing wave-

lengths; some of these were the active rays that synthesized the formaldehyde, and so also the sugar, and others, those that destroyed it as soon as it was formed. To cut out the harmful rays by placing a screen in front of the lamp was impossible, as such a screen would at the same time eliminate the synthetic rays. After several months' work a suitable remedy was found, at once simple and effective. It was discovered that by gently stirring purified precipitated chalk in the distilled water whilst the ultra-violet light played upon it, most of the decomposition could be prevented. Patient research also revealed that by keeping the temperature of the water at 37° C. (about the normal temperature of the blood) the synthesis proceeded most rapidly, whilst decomposition was least.

### Technique.

Having thus discovered what may be termed the optimum conditions, the reactions were carried out on a larger scale than the test-tube one that had been used up to this stage. A rectangular glass tank 15 inches square and 8 inches deep was prepared. A circular hole  $2\frac{1}{2}$  inches in diameter was made in each side and in these holes were fitted quartz tubes, of the same external diameter and 6 inches long, so that the tubes projected inside the tank. Having already found that carbonic acid gas gave formaldehyde with ultra-violet light, Professor Baly omitted this step and filled the tank with a solution of formaldehyde (40 per cent) in pure distilled water. In the middle of the tank an electrically-driven stirring device was fitted to stir the purified precipitated chalk, which was next added, and stirred vigorously until all acidity of the formaldehyde had been neutralized. When this had been done and the chalk had settled somewhat, a quartz mercury vapour lamp was pushed into each



PROFESSOR E. BALY OF LIVERPOOL UNIVERSITY  
WHO HAS MADE SYNTHETIC SUGAR.

of the tubes and its light allowed to play upon the solution.

The photosynthesis is not a rapid process. The utmost yield—of eight per cent of sugars—is only obtained after fourteen days' continuous illumination. When this has been done the solution has to be concentrated by evaporation and then treated chemically with absolute alcohol, zinc sulphate, and chloroform, and finally more absolute alcohol. The final solution, however, is a thick concentrated syrup having a very sweet taste. It is quite transparent, with a colour varying from yellow to pale brown.

#### Mixed Result.

The syrup so made was analysed by Professor J. C. Irvine and G. V. Francis of St. Andrews University. They found considerable difficulty in their analysis as so many different sugars and resinous compounds were present. The total amount of hexoses present

was 20 per cent by weight of the dried syrup. A hexose, it may be explained, is a simple sugar containing six carbon atoms to the molecule; grape sugar or glucose is a hexose, as is also invert sugar. The remaining 80 per cent consisted of resinous compounds, the majority of which were polyhydric phenols, or complex substances something like the phloroglucinol that is used in developers for plates and films.

From this it may be gathered that the process is not in a position to provide the country with a cheap sugar. Nevertheless, it shows what can be done. A start, however humble, has been made, and an example of a humble and expensive start that to-day has produced a cheap and efficient product is that of insulin. Insulin in the course of the last two years has reached a price low enough to suit the poorest diabetic's pocket. Who knows how soon synthetic sugar may be a commercial proposition?

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## The River of Mystery: Secrets and Wonders of the Amazon.

By Charles W. Domville-Fife.

*Late correspondent of THE TIMES in South America ; Author of "Among Wild Tribes of the Amazon," "The Real South America," etc.*

*The Amazon is the happy hunting-ground of the modern explorer and scientist. Despite the fact that the existence of this great river was known three centuries ago, it boasts of great tributaries and huge tracts of primeval forest which have not yet been explored. Hence its attraction to those anxious to tap new ground and learn something of its secrets and mysteries.*

No waterway in the world makes so wide an appeal to every class of traveller as the mighty Amazon, which rises in the Andes in Peru, and flows right across the South American continent, virtually following the course of the Equator, for a distance of 4,700 miles, by far the longest river known. Then we have not yet discovered all its secrets.

### Unknown Tribes.

New wonders are continually coming to light, such as the existence of a new tributary of the great stream that has been located and ascended; a hitherto unknown tribe of Indians that have been found within its dense primeval forests, or some new species of fauna or flora. Sometimes these discoveries are of value to the commercial world, as the finding of a new variety of "balata" tree, while at other times they appeal to the scientist, and again to the lover of the wilds, and the sportsman.

These continual discoveries in the Amazon valley may appear somewhat belated when it is remembered that the existence of the river was announced by that daring adventurer, Pinzon, so far back as the year 1500. Yet those who know the region well will not hesitate to tell you that there are undoubtedly many tributaries of this mighty waterway awaiting their first discovery. I do not mean small streams, but great rivers hundreds of miles in length. In the

same way there are vast tracts of primeval forest, ten thousand square miles and more in area, which have never been explored and which may contain all

sorts of wonders hitherto unknown. This is evidenced from the experience of the late ex-President Roosevelt who, during his remarkable journey through the hinterland of Brazil, discovered an unknown river over nine hundred miles in length, flowing into the Amazon.

### Super-Niagara.

On this river he found a waterfall as wide as Niagara and nearly one hundred feet higher. He also stumbled across a hitherto unknown tribe of primitive Indians, and brought back to civilization hundreds of remarkable new birds, insects, fishes, orchids and plants. Indeed, it is becoming the fashion now for the great universities

to send scientific expeditions into this region. The well-known American explorer, Dr. Hamilton Rice, is now on the Bronco River, while it was only a few weeks since that the members of the Stockholm University returned from the Amazon.

Fortunately for the ordinary traveller the river is navigable for many thousands of miles. Steamers go right to Iquitos, although this old Spanish settlement lies 2,300 miles from the Atlantic, and the river here is a mile wide. The big 7,000-ton vessels of the Booth



A FAN PALM AT PARA.

Line regularly run to Manaus, a most fascinating city, dumped in the very heart of the great primeval forest, lying just over a thousand miles from the river's mouth.

You enter the river by way of Para. It is not situated on the Amazon proper, but lies on the right bank of the stream of that name. Although only some eighty-two miles south of the Equator, it is, nevertheless, a healthy tropical city, boasting of its cathedral, public buildings, electric trams and morning and afternoon journals. One curious fact is that although you are on the Equator, you need have no fear of sunstroke. The sun, almost directly overhead, casts its lurid light on the brazen river, but over the whole forest region there is an invisible haze of moisture, which the light penetrates on its journey to earth. This robs it of the ultra-violet rays that are so dangerous to human life in other equatorial regions.

#### River Road.

You quickly discover that the river is the only highway into the interior, and to reach the cities and settlements that dot the upper reaches of the Amazon you have to pass through the Narrows, the navigation of which is so tricky that in the case of the bigger steamers the services of three pilots are requisitioned. For over a hundred miles you sail along narrow, winding water lanes crowded with large and small islands clothed with tropical vegetation. So narrow is the channel in places that the sides of the boat are swept by the branches of the overhanging trees. You seem to be able to touch the vast equatorial forest. When darkness falls the silence is broken by the harsh cries of the howling monkeys, while occasionally, particularly after a hot and close night, the heavens will suddenly be illuminated with flashes of lightning, but unaccompanied by thunder. These soundless electrical storms are quite awe-inspiring to

watch. The flashes are continually lighting up forest and river in a wonderful way. Then, in addition, there is the ordinary thunderstorm.

Along the banks of this strange waterway dwell many Indians—the semi-civilized descendants of the once great Tupi nation. They can be distinguished from the *caboclos*, or half-Indian rubber gatherers, by their short stature, brown skins and square muscular frames. They live in families, and have a curiously elaborate code of relationship. Cousins are unknown, all the grandchildren of one grandfather being brothers and sisters. The women, both *caboclos* and Indians, either go about semi-naked or dressed in brilliant red skirts, and the men seldom wear more than a pair of dirty shorts and a straw hat.

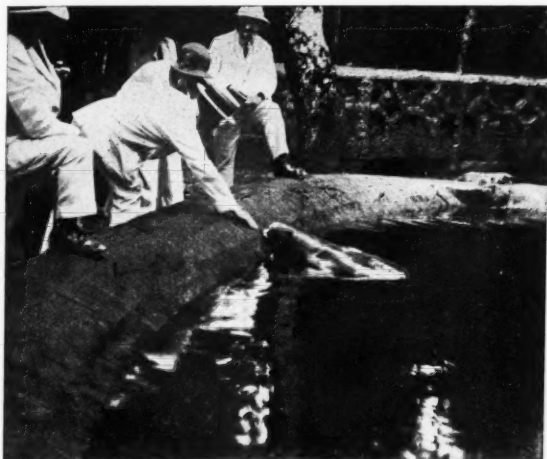
#### Floating Islands.

When you emerge into the main channel you are in a river as wide as the English Channel at Dover. But it is so crowded with large and small islands, and steamers have to pass so close to them and to the shore, that you fail to recognize the immense width of the stream. Distinctly weird are the floating islands. During the flood season small strips of land, two or three feet square, break away from the banks.

Dangling from them are roots of many aquatic plants. They quickly anchor themselves to the bottom of the stream and the little moving patch of earth with its vegetation is brought to a standstill. It is soon joined by others, while all the time it is being added to by the solution carried down by the river. Thus, in time, an island is formed, its only anchorage consisting of a mass of fibrous roots. Big bushes and even trees make their appearance, and then suddenly the anchorage fails to hold, and an island an acre or more in extent, covered with jungle growth, starts on its voyage down the stream—the "icebergs" of the Amazon, as the captains call them. Then you notice a curious phenomena: the yellow water is



NATIVE HUTS AND BANANA PALMS.



A TAME COWFISH IN THE PARK POND

streaked with patches of green, caused by the greenish waters of the Tapajos emptying themselves into the main stream. This is another peculiarity of the great river, the varying colours of its waters. Some of the streams are a jet black, others are almost white, green, or a deep olive hue. Yet the water is actually as clear as crystal. Dip it up and place it in a bottle and it quickly loses its colour or sediment. A curious feature of the Tapajos are its roars and rumblings—the spirits of the waters as the natives term them. They are caused by the waters rushing through underground passages and caverns.

#### A Jungle Paris.

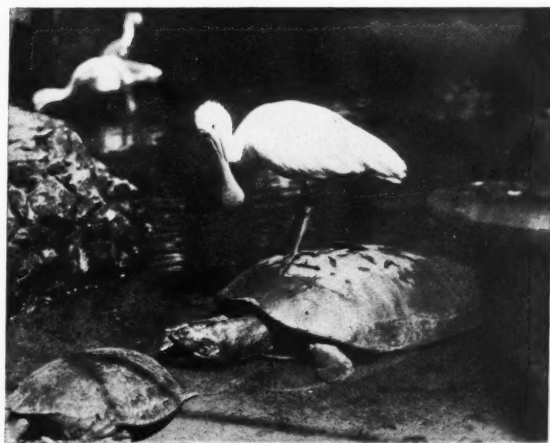
So one journeys on past Obidos and on to Itacoatiara, the centre of the Brazilian nut industry, marvelling at new wonders at every turn. Truly it would be difficult, if not impossible, to find a river trip so varied and so full of novelty. Just beyond Itacoatiara, on the other side of the stream, the Rio Madeira empties itself into the river, a no mean tributary considering that it has a length of 2,500 miles. Passing the picturesque island of Marapata, Manaus looms into view, a white city, set on the edge of the forest, standing on the left bank of the Rio Negro. Although it is a thousand miles from the Atlantic the river here is two miles wide. The white towers, red roofs, green palms and brown earthen banks of this isolated town are all dominated by the great gilded dome of its magnificent opera-house. No railway lines lead out of the city. The river is the only highway to and from this Paris of the Upper Amazon. It is encircled by unexplored forests at least a thousand miles broad in every direction.

In the narrow igarapés, or creeks, around Manaus, that strange aquatic plant, the great water-lily or Victoria Regina, abounds. The leaves measure seven to eight feet in diameter, and, with their stiffly upturned edges, have the appearance of huge trays. They can easily bear the weight of a full-grown man. The flower is not less marvellous than the leaves. When fully expanded the bloom measures from fifteen to eighteen inches in diameter. It has numerous petals, and when the bud first opens the colour is pure white, changing during its brief existence of three days to a rich crimson. It exhales a very pleasant perfume, and to take a boat and row in and out among acres and acres of these plants is a novel experience.

#### Fifty-foot Snakes.

It is in the swamps where the gigantic anaconda lurks. It is popularly referred to as a water-snake, for the reason that it spends so much of its time in the streams. A number have been killed measuring thirty feet in length, but the natives of the Amazon swear they reach fifty to sixty feet in length. An explorer who recently travelled up the Rio Negro brought back to the museum at Manaus the vertebræ bones of one of these snakes. He secured them from a native who told him how a big water-snake used to visit his carrol and carry off cattle, so he laid in wait and succeeded in laving the monster low. When the bones were covered with flesh the reptile must have been thicker round than a man's body and well over fifty feet in length.

Just above Manaus, on the west bank of the stream, would appear to be one of the best spots to see the alligator at home. Here, at sunrise and sunset, shoals of them are frequently to be seen whisking their ponderous tails, or floating idly with the tide. Much



A SPOONBILL INVESTIGATING A TURTLE

ingenuity is used to obtain their valuable skins and fat. The former are used for the shoes and handbags of civilization, and the latter for relieving the rheumatic pains of native sufferers. Sometimes a large piece of hard wood, carefully covered with raw meat, is allowed to float within reach of a shoal of alligators. The teeth of the reptile, which snaps at the bait, become embedded in the wood, which is attached, below the surface, to a strong grass rope. Harmless by being unable to open its jaws, the alligator is also half-drowned. It is then drawn on shore by a number of natives and quickly dispatched. Great mortality is suffered by these native hunters, owing to the numerous tail-whisks and to the fact that when the captured reptile feels itself being dragged out of its natural element, it usually makes a supreme effort to release its embedded teeth, and if successful is liable to catch the incautious hunter and drag him screaming into the water.

#### Unknown Fishes.

There is certainly no waterway in the world which contains such a variety of strange fish as the Amazon and its tributaries. There is the "boto," a kind of river dolphin, which is very fond of following large and small craft. They love to gambol on the surface of the water like porpoises, and have a habit of gasping and snorting violently. To be followed by a shoal of this fish in a small boat at night and watch their sinuous bodies wriggling in and out of the water and hear their snorts is decidedly uncanny. Another extraordinary fish is the man-eating piranha. Although no larger than a common shad or herring, it does not hesitate to attack anyone venturing into the water. In Manaos you can find natives minus fingers and toes which have been nipped off by these ferocious little creatures. A few years ago a young Englishman was killed by piranhas during a regatta at Manaos. The cutter which he was sailing capsized in a sudden squall. His companion escaped, but the Englishman became entangled in the sail. Before he could be rescued his body had been partly devoured by the piranhas. There are also the stinging rays and monster electric fishes. To touch any of these latter means you receive a shock which you cannot shake off for days. Ichthyologists tell us there are 2,000 different kinds of fish in the Amazon rivers—among them many species found nowhere else. A representative of the London Zoo is now on the river collecting specimens for its new aquarium.

Excursions into the forest are often fascinating experiences. You encounter trees of every shape and size, representing innumerable varieties. Swinging down from the branches, shooting upwards from the

earth, crawling over the ground, clambering across rotten logs, knotted, twisted, and inextricably tangled and interlaced, are the lineas, vines and creepers, some delicate as silken threads and others as thick as six-inch hawsers, and everywhere the most beautiful blooms. It is as if Nature had gone mad and had exhausted all her resources in the creation of this floral extravagance.

Then the whole forest teems with wonderful and weird life, though it may be that only at rare intervals do you encounter it. Sometimes a huge ant-bear, so engrossed in tearing a dead tree to bits, fails to hear your approach, and continues his labours and laps up the swarming ants with his yard-long tongue while you watch him; or it may be a lithe and graceful ocelot, or even his bigger brother, the fierce jaguar, so intent on stalking an unsuspecting brush-turkey, a sleepy monkey, deer, or tapir, that your proximity is unnoticed; or again it may be a flock of trumpeters feeding or dancing in some tiny open glade. Far overhead, unknown, unseen, for ever out of reach of puny man, is another world, for in the dense roof of the jungle dwells a host of creatures who never descend to earth. Here is the home of the huge-billed toucan, the parrots, the loud-voiced macaws, and innumerable monkeys; here myriads of bright-hued birds twitter and sing and fly from twig to twig and rear their young; here the slow-moving sloths spend their upside-down lives; and here the fierce harpy eagle, the ocelots, the margay, and the long-tailed cats, the puma, and even the great spotted jaguar, find a happy hunting-ground.

#### X-RAYS FOR CIGARS.

CIGARS are an expensive luxury in these days and science has been invoked to protect imported Havanas against the ravages of the cigar worm. This little brute hatches out from a concealed egg laid on the leaf tobacco and bores its way to the outside world at the expense of a perfect smoke. Heat or gas cannot be applied to kill the pest without ruining the flavour of the cigar. The problem is solved by exposing each box to X-rays which destroy the vermin without affecting the tobacco.

#### PYREX INSULATORS.

THE familiar pyrex glass which is now almost as well known in the kitchen as in the laboratory, is one of the very best of insulators for high-tension electrical work. Those who need critical efficiency in wireless or high-tension apparatus will find the ordinary pyrex glass-tubing supplied for laboratory purposes ideal for insulation or lead-in.

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## The Mechanism of Hearing.\*

By R. J. V. P.

*Some new and extremely interesting research work has been done recently by Doctor George Wilkinson, M.B., F.R.C.S., and Doctor Albert A. Gray, M.D., F.R.S.E., who have been investigating the problem of how we hear. They have succeeded in making a model which demonstrates the physical truth of what has long been only a matter of theory.*

ONE of the most surprising things about science, taking it as a whole, is its dependence on a very few men in each branch for the essential discoveries or theories which made advancement possible. One need only recall the names of Cavendish, Pasteur, and Hermann von Helmholtz to realize that between them they are the first begetters of a great part of modern knowledge. Of the three, perhaps Helmholtz covered the widest field. He enunciated the theories at present accepted in the interpretation of the relationship between the sense of hearing and the sense of vision, and the physical laws of light and sound. He formulated the law of the conservation of energy, and was the real originator of the modern views of the structure of the atom.

Perhaps most people, however, have heard of him with relation to his theories of vision and hearing. Both are problems of somewhat similar nature. We know, by experiment, a great deal about sound and light. We recognize them as examples of wave motion, propagated impulses travelling like ripples on a pond. We can study sound from outside, impersonally as it were, and reduce it to rigid laws; and we are ourselves conscious of the senses of vision and hearing, and can express the sensations which we receive. Between the brain, receiving and recording impressions, and the disturbances in the air or in the "ether" which cause the impressions, are organs which have been minutely dissected and examined. We know the structure of the eye and of the ear. How are these structures related to the known laws of sound and light?

Helmholtz was, as has been said, the first to suggest theories which still, in modified forms, hold the field.

In this book his theory of hearing is alone discussed. But before examining it, it is as well to define the problem which he faced more clearly.

We know that a sound is translated in the ear into a nervous impulse. The sensation of sound, and its relationship with that impulse, are questions rather for the psychologist than the physicist or the biologist. Helmholtz's theory is simply an explanation of the physical structure of the ear.

The ear consists of three main portions: first, the external ear, which is, in man at least, more ornamental than necessary; no apparent loss of hearing results if it be removed. The internal ear is divided into two parts. Everyone agrees that one of these parts is concerned with the sense of balance; the other part, the cochlea, is the essential organ of hearing.

The cochlea is shaped like a snail's shell. It is a tiny little organ, and encased in the hardest bone in the whole body; hence the difficulties which attend its satisfactory dissection. In fact, the authors of this book believe that some false ideas

as to its structure have grown up as a result of the methods adopted in its investigation.

There is no room here for a detailed account of this structure; it must suffice to say that there is a membrane stretched inside the shell-like cochlea, dividing it longitudinally in half which, of course, diminishes in width as the whole of the cochlea winds upwards. This membrane is made up of fibres which, therefore, also diminish in length as the cochlea winds upwards. To these fibres the branches of the great nerve of the ear are linked by what is known as the organ of Corti.

It will be seen that if it were possible to unwind the cochlea it would look like a harp, with long strings at one end, and short ones at the other, or like a grand piano when one looks inside it. If one puts one's

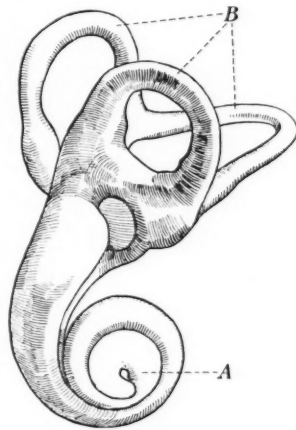
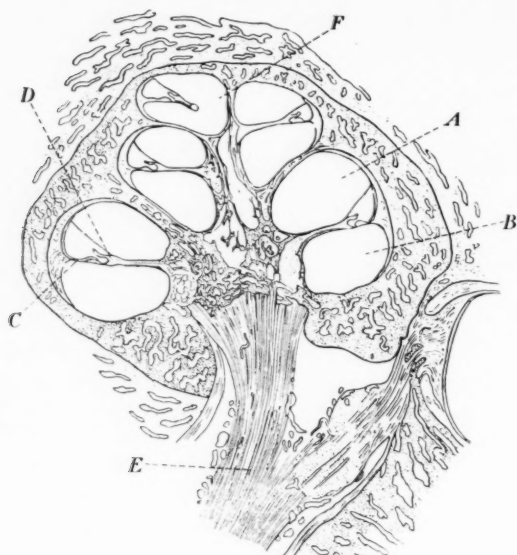


FIG. 1.  
A.—The cochlea, the organ of hearing.  
B.—The semi-circular canals, the organ of balance.

\* "The Mechanism of Cochlea: a Restatement of the Resonance Theory of Hearing." By George Wilkinson and Albert A. Gray. Macmillan & Co., 12s. 6d.



SECTION OF THE COCHLEA.

- A.—Upper compartment of the cochlea.  
 B.—Lower compartment.  
 C.—Basilar membrane.  
 D.—Organ of the Corti.  
 E.—Nerve of the ear running to the brain.  
 F.—Communications between upper and lower compartments of the cochlea.

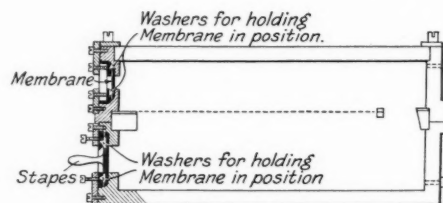
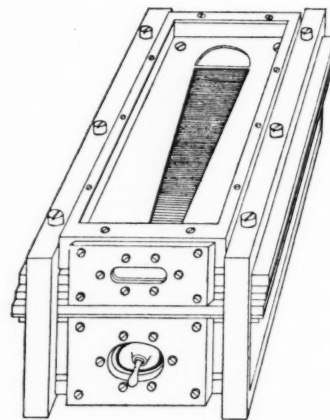
foot on the loud pedal of a piano, and sings a note, it is a familiar fact that the piano will emit the same note by what is known as "resonance." In other words, one has put into action, and made to vibrate, that string in the piano which corresponds to the note sung.

Helmholtz's theory was that the same thing happens when we hear a sound. All sounds, it is known, can be imitated by the proper combination of musical tones. In his view, the fibres of the membrane in the cochlea which correspond to those tones vibrate as does the piano, stimulate the connected nerves, and give rise to the sensation of sound.

That such minute fibres, differing from each other so little in length, could cover the whole range of the sounds we can hear—about eleven octaves in all—seems difficult at first to believe. In this book are discussed the explanations of these and similar paradoxes. It is shown that the amount of tension on fibres of the same length affects the notes to which they resound, just as the length does. If the fibres had to depend upon their length for their power to "resound" to the correct note, and thus make us "hear" the same note, they would have to be 2,000 times longer at one end of the cochlea than the other. Actually they are only about three times as long, but there is every reason to believe that the tension on them is very different.

This book is a most important contribution to the study of the cochlea, by two very well-known authorities. Naturally much space is given to a mathematical examination of the problem, since the whole basis of the theory rests on certain well-known formulae for "periodic motion." But this part of the book may be followed even by the non-mathematical. On the other hand, it is a pity that a somewhat more elementary description of the cochlea itself has not been given, in addition to the most able detailed description. It would not be possible for one completely a stranger to the subject to get a very clear idea of the organ as a whole from this book alone.

A very interesting description of a working model of the ear is given, with instructions for its manufacture. In order to explain it, it is necessary to add a few words to the brief outline of the mechanism of the ear which has been given above. The waves of sound, collected in the outer ear, strike the ear-drum, and set up vibration in it. This vibration is transmitted by a series of tiny bones to a final bone, shaped like a plunger, which is inserted into the cochlea. The cochlea is itself filled with fluid, and the movements of the plunger set up corresponding waves in the fluid. It is the waves in the fluid of the cochlea which make the fibres of the membrane "resound" as has been described above.



THE MECHANICAL MODEL OF THE COCHLEA

The two illustrations given here of the internal ear may serve to give some idea of its naked-eye appearance. On the left in Fig. 1 (which is not natural size) is the part of the ear concerned with balance, on the right is the cochlea. Fig. 2 shows a section through the cochlea. The division of the spiral into an upper and lower part is shown, and it will be seen that the two are in communication at the top. The membrane does not extend the whole way across. Certain details which for our purpose are not important are omitted.

The model represents a cochlea whose spirals have been straightened out. It is a long box (Fig. 3) filled with fluid, and divided into an upper and lower compartment, just like the cochlea, by a partition which represents the basilar membrane. The upper and lower compartments communicate at one end as in the cochlea.

The "basilar membrane" in this model is made of short strips of phosphor-bronze ribbon. The different tension of separate "fibres" is achieved by attaching weights to one end, and soldering the wire under tension. The continuity of the fibres is assured by covering them with cigarette paper.

If, now, a tuning fork be struck and applied to the little plunger, vibrations are transmitted to the fluid. A coloured insoluble powder is distributed over the "membrane." If the theory of Helmholtz

be correct, these phosphor-bronze fibres which correspond in period to the tuning fork's period will vibrate by resonance. This is found to happen. The indicator powder all collects over the area corresponding to the vibrating fibres. In other words, contrary to what one would expect, all the powder is collected at the point of maximum movement. It is possible in this way to imitate exactly what happens in the ear when a sound wave reaches it.

In the ear, of course, the "resonance" of the suitable fibre stimulates a special nerve, and a nerve impulse is carried to the brain and there translated into the sensation of sound. It is not possible to analyse that side of the sense of hearing; but it might be paralleled if we were to attach electric circuits to each separate fibre in this model, so that various little lamps flashed as tuning forks of different kinds were applied. In that way we could imitate the transformation of sound waves into something quite different. For the ear is really only a machine for translating movements of the material air into the only coin the brain deals in—nervous impulses.

We would recommend all those who are interested, professionally or otherwise, in the mechanism of the ear, to read this book. It is the most important single contribution to the subject since Helmholtz first enunciated his theory.

### ROYAL INSTITUTION.

THE before-Easter lecture arrangements at the Royal Institution have just been issued. The subject of the Christmas Course of Lectures for juveniles is "Concerning the Habits of Insects," to be delivered by Mr. F. Balfour Browne, beginning on 27th December, on Insect Collecting, followed by The Habits of Bees and Wasps (30th December), Caterpillars (1st January), The Dragonfly (3rd January), The Water-Beetle (6th January) and The Habits of Insects and the Work of Man (8th January). The general courses will begin on Tuesday afternoon, 13th January, at 5.15, when Professor A. Fowler will commence a course of two lectures on The Analysis of Spectra; on succeeding Tuesdays there will be two lectures by Dr. H. R. Hall on The Prehistoric Greek and Ancient Egyptian Civilizations, four by Prof. Barcroft on The Colour of the Animal Creation, two by Prof. E. N. da C. Andrade on The Evolution of the Scientific Instrument, and two by Prof. A. S. Eddington on The Internal Constitution of the Stars. Thursday afternoons at the same hour, beginning on 15th January, Mr. J. S. Huxley will give two lectures on The Courtship of Animals and its biological bearings; Sir William Bragg four on The

Properties and Structure of Quartz; Sir A. Smith Woodward two on Dinosaurs; Dr. Leonard Hill two on The Biological Action of Light, and Mr. T. Thorne Baker two on Chemical and Physical Effects of Light. The Saturday lectures will commence at three o'clock on 17th January, when Prof. G. Gordon begins a course of two lectures on (I) The Women of Shakespeare; (II) Shakespeare and the Spirit of Comedy, to be followed by two lectures by Canon E. H. Fellowes on (I) The Elizabethan Madrigal; (II) The Elizabethan Ayre, with musical illustrations; two by Mr. W. Rothenstein on The Artist's Relation to Social and Religious Life; four by Sir Ernest Rutherford on Counting of the Atoms; and two by Prof. J. H. Ashworth on a zoological subject to be announced later. The Friday evening meetings begin on 16th January with a discourse by Sir William Bragg on The Investigation of the Properties of Thin Films by means of X-rays. Succeeding discourses will probably be given by Dr. A. W. Crossley, Professors J. W. Gregory, R. W. Chambers, T. H. Pear, Gilbert Murray, J. W. McBain, Principal Irvine, Mr. W. B. Hardy, Sir Ernest Rutherford, Sir Daniel Hall, and other gentlemen.

## Recent Developments in Science.

A Review by J. Riley, B.Sc.

*From time to time we shall publish a general view of developments in science, but it has not been found practicable to devote a set amount of space to the feature in every issue. Readers may however rest assured that all important advances will be treated in articles independent of these short reviews.*

### SEX DETERMINATION IN BIRDS.

ONE of the scientific fronts in which many important advances have been taking place is that of Genetics. An article by F. W. Rogers Brambell, B.A., Sc.B., Ph.D., in *Science Progress* for October, 1924, on "Sex-determination in Birds," usefully summarizes the progress that has been made in connexion with this aspect of biological science. Dr. Brambell believes that "recent research has revealed so much concerning the causes which underlie and determine sex that . . . we are on the threshold of a far fuller understanding of this aspect of life." The article deals with our knowledge of the determination of sex in birds. It is clear, however, that the far-sighted experimenters are much more ambitious in their expectations than their subject would appear to suggest. In Professor Punnett's words, quoted by the writer of the article, "It is likely that many a problem in human ethics will be brought nearer to solution by an intensive study of cocks and hens." The scientist must use for his experiments and observations the most readily available material. But his constant hope is that the results so obtained may be fruitful in their application to a much wider and more important field.

The general purpose of the article is to bring forward facts which suggest the need for modifying the sex-chromosome theory, which is commonly referred to as an explanation of the primary cause of the sex of any individual. According to this theory, what the sex will ultimately be is finally settled at fertilization, being determined by the nature of the chromosomes contained in the fusing sperm and ovum.

#### Abnormal Conditions

If this theory is correct, then the sex of every individual will be a fixed and unalterable thing. Dr. Brambell brings to our notice the following sexual abnormalities in the adult fowl which show that sex-determination is by no means so definite as we should suppose:—

(1) First of all, there are the "individuals which are more or less completely hermaphrodite throughout life." An example is quoted of a Rhode Island Red which "was an apparently normal pullet for the first

year. Then the combs and wattles began to enlarge and the bird learned to crow. Its behaviour was in some respects male, in others female." This particular bird is quoted as being of unique interest, inasmuch as post-mortem examination showed it to possess "actual functional ovarian and testicular tissue at the same time."

(2) A second class is that of what are called "gynandromorphs," in which the two sides of the body seem to be opposite in sex. Thus a bullfinch is referred to "in which the left side was female in character and sharply separated from the right side, which was male. The plumage of the right side was that of the normal male—in marked contrast to the duller female plumage of the left side. Corresponding to these external characters a testis was found to be present on the right side and an ovary on the left."

#### Sex-Reversal.

But the most curious cases of all are those in which the sex of the adult bird actually changes. The only direction in which this change is known to take place at present is from female to male. The cases noted have all been those of "females, usually old birds of good laying strains." The only assignable cause of the change is the degeneration of the ovary, this being "accompanied by the development of testicular tissue and the more or less complete assumption of the male character." A case is quoted of "a Buff Orpington with a good laying record which had hatched chickens from its own eggs. At the age of three-and-a-half years changes began which resulted in the transformation into a male. On being mated to a virginal hen two chickens were bred from it; one was a male and the other a female." In its final stage the feathering and head of the bird were entirely male in character. It still, however, retained its female carriage.

Examples of this kind suggest that "maleness and femaleness are not mutually exclusive." They are both "present potentially in every cell of the organism throughout its life, and may at any time be expressed under the influence of suitable causes." Among the causes, "nutrition, hormone action and other metabolic and pathological conditions probably play their part."

### IODINE AND THE THYROID.

RECENT articles by the well-known medical correspondent of the *New Statesman* have drawn attention to the far-reaching results which are to be anticipated from the discovery of the relation of iodine to the efficiency of the thyroid gland. The importance of the thyroid gland itself is, of course, generally recognized. Among the numerous functions of the secretions of the thyroid we may quote the following from the exhaustive list given by Dr. Sidney Barwise, Medical Officer of Health for Derbyshire—a part of the country which is well known for the prevalence of goitre, sometimes called “Derbyshire neck.” According to him, the healthy working of the thyroid is absolutely necessary for proper growth and efficient mental development. A severe shortage before birth leads to cretinism, a condition common in Switzerland, “the home of goitre,” where cretinoid idiots and deaf-mutes fill the asylums. The thyroid secretion is vital during adolescence. It is also needed to keep the skin and hair in a healthy condition—dry skin and falling hair frequently meaning thyroid deficiency; and to digest and assimilate fats—the deficient functioning of the thyroid being thus one cause of obesity. Finally, it is more than possible that the thyroid plays an important part in keeping up the resisting power of the body against infectious diseases.

#### The Action of Iodine.

The health of the thyroid is thus of supreme importance. And we know that it depends upon the regular supply to the body of a small but indispensable amount of iodine. This discovery was made in connexion with the hatching and rearing of young fishes in fresh-water hatcheries. The water used was unnaturally pure, and it was noted that all the fish developed goitre. The addition of a little iodine to the water, however, led to their prompt recovery.

Upon first thoughts, it may seem queer that such a substance as iodine should be so essential. The reason, however, is not far to seek. The source of iodine is the sea. Iodine forms a small fraction of the solids which are left when sea water is evaporated. It is iodine, of course, which gives certain kinds of seaweed their brownish colour. Although ages have passed since our remote ancestors left the sea behind and crawled on land, we have never lost our craving for salt or our need of it. Further, to quote the article on “Iodine and Public Health” which appeared in the *New Statesman* for October 25th, “There is reason to suppose that our blood, at this hour, is marine in type, that it contains those salts, and in similar ratios, which are to be found in the ocean but much

more diluted, because the ocean at the date when we left it had not received that vast increment of salts which all the rivers, ever since, have been perpetually washing into it from the land.”

#### Practical Measures.

The purpose of the table salt we use is thus to provide these “marine constituents” which we still require. The mistake which has been made has been to make our salt too pure and to restrict it to sodium chloride and ignore “the minor constituents of sea water, particularly those containing iodine.” There are, of course, other sources of iodine in the food which we eat—particularly the cereals, fruits and vegetables. It is in the husk, skin and surface of these that the iodine is chiefly concentrated.

Practical measures have already been taken to apply the discovery in those parts of the world where thyroid deficiency is most serious. America has a marked “goitre belt,” and in Rochester, New York, iodine is now being added to the water supply. In Switzerland, the method used has been the supply of iodine to school children in a tablet or two of chocolate, distributed every week. Iodized salt is also gradually coming into use. The amount of iodine which this contains is extremely small, being only about one part in 200,000. The result has been described, in the case of the Swiss Canton of Appenzell, as being miraculous. No fresh cases of goitre are occurring, and no cretins are now born.

### PLANTS AND ARTIFICIAL SUNLIGHT.

AN article on the “Effect of Artificial Light on the Growth of Plants,” which appeared in the issue of *Nature* for 15th November, hinted at important developments which may be expected in connexion with the study of the effect of light on the life of plants. It is, of course, generally known that light is essential to maximum growth. Thus plants grown in the shade are stunted as compared with those grown in the open, and their flowers are usually fainter in colour. Vegetation grows with unexpected rapidity in the Arctic regions during the long summer day, and corn ripens very quickly in the parts of Norway and Sweden where the summer lasts no longer than eight or nine weeks, but where, on the other hand, the sun scarcely sets during this time.

If the light has this affect upon plant life, it is not surprising that experimenters have attempted to accelerate the growth of plants by extending the natural day by adding on to it an artificial day in which artificial light takes the place of the absent

sunlight. The difficulty hitherto has been to obtain artificial light of sufficient intensity. The strength of the artificial light must at all events be comparable with that of sunlight. The difficulty will be realized when it is stated that direct sunlight in summer may have an intensity of 10,000 foot-candles, while an artificially lighted building usually has an illumination of no more than 10 foot-candles.

In order to affect the growth of plants, an intensity of at least several hundreds of foot-candles is required. This can now be attained by the use of electric gas-filled lamps, of 1,000 or more candle-power, and fitted with reflectors which enable the light to be concentrated upon a comparatively small area. With lamps of this kind, experiments have recently been made at a number of agricultural stations in the United States. Some of the results obtained were recently given in papers which were read before the American Illuminating Engineering Society.

The most marked effect of using extra light was in quickening the blooming of flowering plants. Thus Professor H. Findlay, of Columbia University, reported that "marguerites came into bloom eighteen days after the lights were turned on, when similar plants, grown only under sunlight, were scarcely showing bud."

It is not expected, of course, that artificial light would ever be of much use in the raising of ordinary plant foods on a commercial scale. It is, however, a perfectly feasible method of raising scarce fruits and flowers out of season.

#### ATMOSPHERIC DUST.

THE ninth report has recently been issued of the Committee for the Investigation of Atmospheric Pollution (H.M. Stationery Office, 4s. 6d. net). Among many other interesting items of information, the report has a good deal to say upon the nature of the dust which is contained in the atmosphere upon various occasions and in different places. Thus the number of dust particles contained in the air per c.c. varied from 15 in the middle of the Bay of Biscay, to 4,000 on a hot sunny day in Kensington, and 53,000 on a very foggy day in Westminster, when the limit of visibility was only about 30 yards. In size the average particles were about one-tenth the diameter of the thread of a spider's web. It is their number which is most disconcerting. As the report states, "It may be of interest to the general public to state that during a heavy smoke fog in London, a man would breathe in the course of 24 hours of such fog 500,000,000 particles of suspended matter. Their size is such that if placed in contact these would form

a string of about 250 miles in length. This way of looking at the degree of pollution of the air gives some idea of the work which must be done by the cilia and cells of the respiratory organs to remove the impurities breathed in."

#### THE DAVY LAMP.

IT is well over a hundred years since Sir Humphry Davy made his investigations into the nature of fire-damp—the cause of explosions in coal-mines—as a result of which he invented his well-known wire-gauze safety lamp. We are reminded of this by the publication of a report by Captain C. B. M. Platt, M.B.E., on "Test of Miners' Flame Safety Lamps" (published by H.M. Stationery Office; 3d. net).

After reading this report we realize how much it is to the credit of Sir Humphry Davy that the mesh of the wire gauzes in use to-day is precisely the same as that of the first Davy lamp. The object of the test was to determine whether the mesh could safely be altered. The present gauzes have 28 meshes to the linear inch, the tests made being upon gauzes with 20 meshes to the linear inch. The advantage of the more open mesh is clear. The possibilities of ventilation to the lamp are increased by enlarging the mesh, and this considerably increases the lighting power of the lamp. The experiments made showed that with gauzes of 20-mesh the candle-power of the majority of the lamps in use would be increased by about one-third.

The chief point at issue was whether the larger mesh would be sufficiently safe. The tests applied were most rigorous. In a typical test, the lamp was placed alight, with the combustion tube and inner glass removed, in a current of the most explosive mixture of petroleum ether and air, the speed of the current being at least 1,200 feet per minute. The gas lighted and burned inside the gauzes, which soon became red-hot. After two minutes of this treatment, the lamp was tilted, first away from the current, and then towards it. The total test lasted six minutes, at the end of which it was stopped and the lamp removed for examination. It was too hot to hold in the hand, and the severity of the test may be judged from the fact that "a considerable quantity of iron oxide fell from the wire gauze when the latter was removed from the lamp." As a result of an exhaustive series of tests of this kind it was impossible to secure a single failure of the 20-mesh gauze to prevent ignition of an explosive mixture outside the lamp. It is to be expected, therefore, that the larger mesh will shortly be adopted universally, with its appreciable advantage of increased lighting power.

## Flagellates.

By Sir Arthur E. Shipley, G.B.E., F.R.S.

*Is Euglena an animal or a plant? The question has not yet been decided, for both botanists and zoologists lay claim to the creature.*

WE have seen in the last two articles that the Slipper-Animalcule and the Bell-Animalcule are largely dominated by cilia, whose flickering motion enables the former to move forward, and the latter to bring food to its mouth and fresh water laden with oxygen to its body. But there is another group of animals which we also find in infusions. This group is dominated not by cilia, but by a single large cilium, in this case called a flagellum. One of the commonest of these, named scientifically *Euglena viridis*, is of a deep green colour, for it has on its body the green colouring matter called chlorophyll, which is rare in animals but common enough in plants.

*Euglena* is a very minute organism. At one end of it is the single long flagellum, which is highly contractile and goes through a series of spiral movements, the result of which is that the animal is dragged behind it, just as an aeroplane is dragged along by its propellers. No structure can be discerned in the flagellum even with the highest power of the microscope, and its movements are something like those of a finger when beckoning. There are other flagellates which have their flagellum behind, and their bodies are pushed forward by its motion just as a shore-boat is propelled by a boatman waggling an oar at the stern. The fixed end of the flagellum is anchored in a small pit, and its root can be traced through the body to the stiff ectoplasm. The body of the *Euglena* is shaped rather like a blunt torpedo and it goes through a series of very curious movements which are called euglenoid. It is as if the ring of lesser diameter than the body is pressed over the soft yielding protoplasm; as it passes backward the hinder part is compressed whilst the front swells out. Now it swells up at the hinder end, then in the middle, and then in the front end. These various movements are shown in the illustration on page 34. The whole body is enclosed in a fairly dense cuticle which is prolonged into the little pit in front, and the cuticle shows obliquely parallel lines which may possibly represent some specialized muscular development of the ectoplasm. But the lines remain when the organism is crushed and the cuticle separated from the body, so that this view is probably not true. About one-third of the length of the body from the interior end is a spherical nucleus.

We have said above that the *Euglena* is green, and when they exist in great numbers, as they sometimes

do, the water in which they live becomes of a bright green tint. But the greenness is not diffused throughout the protoplasm of the body. It is confined to certain spherical or ovoid discs known as chromatophors. Each chromatophor is a separate portion of the protoplasm; through it and it alone the chlorophyll is uniformly diffused. The presence of this green substance enables the animal to do what green plants are doing in sunlight, i.e., to form a starch-like substance known as paramylum. This carbo-hydrate has the same chemical composition as starch  $C_6H_{10}O_5$ , but it reacts differently and gives no blue colour, as starch does, when exposed to iodine. When there are large numbers of *Euglenae* in a test tube in bright sunlight, bubbles may be seen forming, and if these be collected they will be found to be bubbles of oxygen. Both bubbles and the formation of paramylum cease when the *Euglenae* are kept in the dark. The same is equally true of green plants. From the above statement it seems clear that the nutrition of *Euglena* differs from that of ordinary animals. It can build up starch owing to the presence of chlorophyll. It has not been definitely shown that *Euglena* takes any solid food, but as it will live for many weeks in complete darkness, and as it lives in an infusion of organic matter it is said to be saprophytic, that is to say, it can absorb organic substances in solution by the surface of its body. *Euglena* is, in fact, a kind of intermediate stage between an animal, a green plant and a fungus.

Just behind the base of the flagellum is a vacuole which opens into the pit mentioned above. This is sometimes termed the reservoir, and behind it lie two contractile vacuoles which discharge into it, and it in turn probably gets rid of waste nitrogenous matter into the pit, sometimes called the gullet. At the front end of the reservoir is a pigment spot called the stigma. This contains a number of minute red granules and, according to some observers, it has in addition a reflecting granule or two of paramylum, the whole structure thus resembling the most rudimentary eye that we are acquainted with. Whether it acts as an eye or not it is impossible to say.

*Euglena* multiplies by dividing into two, and this it does longitudinally and never transversely. The division begins at the front end and gradually passes

## Book Reviews.

*The Remote Past and Hidden Depths of the Earth.* By H. JEFFREYS. (Cambridge University Press. 16s. net).

In recent years astronomical science has made amazing strides. It has learnt to plumb the inconceivable remoteness of the most distant nebulae and star-clusters, and even to predicate a limit to the dimensions of space itself; but we have, strange to say, still only a fragmentary and imperfect knowledge of the conditions that prevail in the earth's interior close beneath our feet. The deepest shafts and borings do not reach a couple of miles, and though the relations of the strata where they are exposed to view enable us to form in many cases an opinion as to their downward continuation, such inferences extend to a depth of three or four miles at the most. We are almost equally ignorant of the distant past. It is true that geology tells us much of bygone days upon the earth, forms of life that have passed away, vicissitudes of climate, movements of land and sea, and igneous activities; but it affords no generally accepted time scale. The estimates for instance, of the age of the coal we burn in our grates vary from 30 to 270 millions of years. It is as if we were not decided whether the signing of Magna Charta took place 80 or 700 years ago.

In these circumstances we turn to our mathematicians for aid and ask them to calculate, with the aid of physical principles and data, backwards from the present to the past. In so doing they will be able, at least we hope they will, to tell us not only something of the origin of our planet, but also of the nature of its interior deep down below the surface.

In Dr. Jeffreys' recent publication "The Earth, its origin, history and physical constitution," we are provided with a full discussion of the problems that present themselves and of the conclusions that have up to the present been reached; and much of this is now published for the first time. From its pages we are able to gather something like a connected story of how the world on which we live had its beginning and of its internal structure.

There is no space to do justice to the valuable chapters on tidal friction and the significance of the annual and fourteen-monthly movements of the pole; to the discussion of the American planetesimal hypothesis, which anticipated in some important respects the views of British astronomers and mathematicians, and of many other matters of interest to students of the earth's history and constitution; but I should like to voice the gratitude which all geologists must feel to Dr. Jeffreys for his careful consideration of the geological standpoint and of geological conclusions. Too many geodesists appear to be not only for all practical purposes ignorant of the elementary teaching of geology, but almost to be unaware that such a science exists.

But gratitude, it is agreed, includes a hope of favours to come. It is a tribute to the value that its readers attach to Dr. Jeffreys' book that they appear to be unanimous in asking that a second edition should be provided, with a still fuller index to the variety of information and argument that it contains, and above all a table, as far as is possible, alphabetically arranged, of the symbols employed, with references to the pages in which they are met with, as well as brief indications of their meaning.

He traces the evolution of our earth and the rest of the solar system from the remote time—thousands of millions of years ago—when the primitive sun suffered tidal disruption from the passage, close in its neighbourhood, of a still larger star. Then with fascinating mathematical resource, relieved by intervals of clear

straightforward statement in plain English, that even the man-in-the-street can comprehend, he discusses the problem of how the world, a whiff of vapour thrown out from the sun at the moment of disturbance, has assumed the familiar features that it now possesses—wide oceans and continents and lofty mountain ranges.

J. W. EVANS.

*Freshwater Aquaria.* By the REV. GREGORY C. BATEMAN, A.K.C. Third Edition. (Bazaar Exchange and Mart. 4s. net).

The opening of the Aquarium at the Zoological Gardens has given a considerable impetus to private interest in small aquaria. This book can be earnestly recommended to readers of DISCOVERY who are interested in aquaria, either as hobbies or as a source of biological inquiry.

Bateman's book is undoubtedly the best on the subject. It is clear, accurate, and extremely comprehensive, for it deals not only with British and foreign fishes and waterweed, but with molluscs, water-beetles and small fry down to Daphnia, the larvae of waterflies and minute insects. It is the only book of its kind with which the reviewer is familiar which can be depended on as a sound guide to pond-life. With it you can identify the most diverse haul of oddities that ever came up in a nature student's net.

The practical side of aquaria construction and very valuable hints on how to keep and feed specimens make it a book of importance to the amateur.

H. P.

*Space and Time.* By CARL BENEDICKS. Translated by J. HARDEN. Introduction by SIR OLIVER LODGE, F.R.S. (Methuen. 4s. net).

We have had so much Einstein and Einstein derivatives recently that a book which is not essentially Newtonian but which conceives of space and its measurement as a fixed solid, is genuinely worth attention. Benedicks is a stimulant, he puts up ideas. He contradicts the wave theory of light, and is solid for the emission theory and he scraps the ether.

The whole of physical science is in such a state of unsettlement at the present time that conceptions of space and time are in themselves confused. The book does not pretend to advance a fully-worked-out mathematical argument, but it puts forward a very convincingly traced series of reasons for alternatives to the present ideas in fashions. The book is clear and readable, and can be recommended to those who have followed recent developments in the theories of physical science.

*Glimpses of Japan and Formosa.* By HARRY A. FRANCK. (Fisher Unwin. 10s. net).

This is one of the modern kind of travel books which avoids compressed guide-book and gives you a real idea—not necessarily a pleasant one—about the people of the country visited. The author's transatlantic style may irritate some people and at times obscures a meaning, but nevertheless it is a very readable book. We have had far too much flowery slush about Japan and the beauties of Old Japan. Here are some of the impressions that New Japan imposes on a not deeply critical but accurately recording observer. He sees below the veneer, records the flashy cunning, and chronicles the monkey strain of East aping West.

The book may be superficial, but the Japanese are more so, and as we may have to look Eastward to the next clash of empires, the book has a timeliness and value of its own. Decidedly readable.

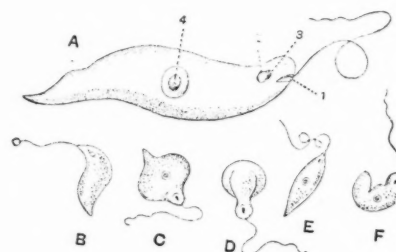
backwards so that for a time we have two organisms, but still fused together like the Siamese twins. The nucleus divides, becoming at first bell-shaped, and then the constriction thins away until it disappears. There are now two flagella, a new one having been formed on one of the splitting halves of the body. At times the little animal encysts, that is to say, it becomes spherical and surrounds itself with a coating of a gelatinous substance. Under certain conditions these encysted forms may be found in enormous numbers with their gelatinous walls coalescing, and the whole forming a scum underlying the surface film of the water or overlying the stones or other objects at the bottom of the pool. After undergoing a "rest-cure" for some time, the contents of the cyst divide into two, each develops a flagellum, and escaping from the cyst they swim off as young specimens. Occasionally each of the daughter *Euglenae* divide again into two, so that one may find four or even eight young *Euglenae* encapsuled in the cyst. After a time the coating bursts and the young emerge. So far no conjugation has been observed amongst this group.

#### Hard to Classify.

The question whether *Euglena* and allied forms are plants or animals is a very debatable one. The presence of chlorophyll, the building up of carbon-dioxide and water into a starch-like substance, and the fact that allied forms can live on organic matter in solution, all rather indicate that they are plants. On the other hand, the absence of cellulose, the fact that they are motile and have a flagellum, points to their being animals. But these criteria will hardly bear rigorous examination. Many undoubted plants, for instance the sea-weeds, the ferns and the mosses, move about by means of flagella in certain stages of their life-histories. Further, certain sea-squirrels (ascidians) which undoubtedly are animals, form cellulose in their bodies. The fact is that we have come to some of the most rudimentary and primitive organisms that we know; and I was going to say that we have come to the most rudimentary plants or animals; but the word "organisms" is a useful term, as it denotes anything that is living, without committing oneself as to whether that living being is an animal or a vegetable. We might, in fact, regard *Euglena* as an animal which is trying to become a plant, or as a plant which is trying to become an animal. But the more logical and accurate way is to regard it as an organism which has not yet placed its cards upon the table and determined whether it will go in for a vegetable or animal career.

There are very many different kinds of flagellates. Some, such as *Polytoma uvella*, have two flagella, both

of which are actively employed in swimming. This form is colourless and has no chlorophyll to give it a green tinge. Others exhibit a very considerable variety of complicated and more highly developed organs than those we have considered above in the body of *Euglena*. Some of them form a spherical



*EUGLENA VIRIDIS.*

A  $\times 100$ , B, C, D, E, F  $\times 200$ , showing the different shapes assumed by the animal during the euglenoid movement. 1. Pharynx. 2. Contractile vacuole. 3. Pigment spot. 4. Nucleus.

perforated skeleton of flint with a single flagellum waving out through one of the perforations. Others have a skeleton of cellulose, possess chlorophyll, and live entirely as plants. Some have two grooves, crossing each other at right angles, along which the flagella lie. The longitudinal groove shields a minute flagellum and in each transverse groove there is a short and thick flagellum sometimes termed the tentacle. The largest of these, *Noctiluca*, is visible to the naked eye. Sometimes the sea is so full of them that it looks like soup. They are phosphorescent, and as Pepys records, he noticed "the strange nature of the seawater in a dark night, that it seemed like a fire upon every stroke of the oar." Another group has a protoplasmic funnel or collar standing up at one end from the centre of which a flagellum protrudes. The collar is sticky and particles of food are brought within it by the movement of the flagellum and then pass into the body. But the most striking of all the flagellates are certain forms which live in the blood or other fluids of the vertebrates. One of these, the *Trypanosoma*, has its flagellum bent backwards, and the base of it is connected with the body by an undulating membrane. One form of these parasites causes the deadly sleeping sickness of Africa. It is conveyed from man to man by a special fly which sucks the blood of an infected person and passes it on to a healthy human being. Still another form causes the deadly horse-sickness, the Nagana, of South Africa. This also is conveyed by a fly, and it is very dangerous to pass through "fly-belts" unless your horses have been salted or made immune.

*Chemistry and Atomic Structure.* By J. D. MAIN SMITH, B.Sc., Ph.D. (Ernest Benn Limited. 12s. 6d.).

By writing this book Dr. Main Smith has put in his debt all who are interested in the fundamental facts and theories of chemical science. It is not a uniformly good book, but, taking it on the whole, it is a book that was well worth the writing; it is a book, in my opinion, which may become very good in subsequent editions. There has been of late no shortage of books on atomic structure, on the nature of the bonds that hold atoms together, and matters of that kind, but most of these have been definitely mathematical or physical in outlook and have not concerned themselves principally with the chemical properties of matter. Dr. Main Smith gives us the contribution to the problem from the chemical side; he reveals to us the chemist's point of view.

The first six chapters of the book deal fully with the underlying facts of chemistry—atoms, molecules, valency, electro-chemistry, stereo-chemistry and the classification of the elements. There is a fresh and original note about much of this description which lifts it above the level of the ordinary textbook of chemistry. The reader too is grateful for the full list of references to the literature which are cited. After these fundamentals have been brought before his mind the reader is plunged into the difficult field of modern hypotheses and speculations upon molecular and atomic structure. One chapter deals with Werner's co-ordination theory, another with co-ordination stereo-chemistry, a third with valency and sub-atomic chemistry, and a fourth with radioactivity. The concluding chapters discuss the physics of the atom, especially of that pictured by Rutherford and Bohr, and relates its properties to the chemical properties of the elements.

Dr. Main Smith has done what is rarely done nowadays, and that is, promulgated original ideas in some detail in a work that is partly a textbook of ascertained and accepted facts. There is no objection to this; indeed, it gives an added interest to the book; but it has its drawbacks. The uninformed or uncritical reader cannot be expected to distinguish between accepted facts and new ideas, or to separate new ideas that are good from mere perverse or fanciful speculations. It is true that in his preface the author announces the subjects upon which he has pronounced new views, so that the reader, if he so desires, may be put on his guard. But an author who mingles his own unaccepted views with accepted ones, be they his own or those of others, can hardly avoid colouring the latter, or at least taking definite sides.

Among the subjects on which Dr. Main Smith has original views are artificial disintegration, the atomic weights of actinium and its series, and the interpretation of electronic structure from the phenomena of radioactivity. He criticises also such subjects as the co-valency bond of two electrons, and the "relativity effect." He proposes a law of uniform atomic plan and he generalizes Werner's co-ordination theory. Some of this is good or at least fresh, but there is some which would have never seen print if the author had but taken counsel with those whose special subjects he is interpreting. For example, it is as clear as daylight that when he tries to say something new on radioactivity the author goes wrong. His statements and the bibliography at the end of his book show that he does not know where to go for recent developments in this subject. No one has done more for the chemical side of radioactivity than Dr. Hahn of Berlin. Yet in this book, which chronicles the development of the subject, this name is not mentioned.

An author is entitled to express his own views in his own book, but surely a reader may criticize the following. After a brief account had been given of the labours of many distinguished chemists in a difficult field, the author informs his readers gravely, "Professors Thorpe and Morgan both agree that the time is not yet ripe for the application of general electronic theories to organic chemistry." Few chemists would agree with the author here. And, indeed, if it be not carping to ask, what time was ever ripe for any discovery? It is surely only after the discovery has been made and has influenced its time that the historian notices that the time was ripe for it.

These, however, are remediable faults, and are mentioned because I should like to see a good book better. In a future edition I hope he will set these matters right.

*Electrical Measuring Instruments. Part II.* By C. V. DRYSDALE, O.B.E., D.Sc., M.I.E.E., and A. C. JOLLEY, A.M.I.E.E. (Ernest Benn Ltd. 55s. net).

This is the second and concluding volume of a work that will undoubtedly remain for many years the authoritative book upon the subject. The present volume describes amongst other instruments the various types of continuous current supply meters, indicating and recording induction instruments, frequency phase meters, synchroscopes, leakage indicators and ohmmeters. The chief concern of the book is with commercial indicating instruments, and it is certain that no one who is directly or indirectly interested in these can afford to be without the valuable assistance that is to be gained from this complete and painstaking work. It will be equally useful to those who make and design electrical instruments, as to those who need to use them. Students of technical electricity will be unable to find any other book on the subject equal in value to this.

The authors have approached their subject in a rather unusual spirit. They have clearly aimed at producing a work that shall be unrivalled in completeness. But they have not fallen into the error of making it a catalogue. The accounts of the various instruments are none of them cut down to a bare description. The theory of each type is dealt with very clearly and simply, and further, with the weight of years of thought and experience, the matter is dealt with throughout in a sane and critical spirit that not only points out the merits and weaknesses of each type, but carries criticism to a constructive ending by pointing out the means whereby the possible errors may be overcome.

The writing of the book has clearly been a labour of joy—despite the long-continued labour that has undoubtedly been involved. This is no hasty compilation. It has involved years of study and thought willingly undertaken, and, as is only to be expected, the thoroughness of the work is evident upon every page, while the pleasure of writing is reflected in the equal pleasure of the reader in encountering a highly technical work which is pleasant as well as profitable to study.

There is an excellent chapter on the various ingenious electrical devices which have been devised for mechanical testing, while the work fitly concludes with an account of the proper test-room equipment which is necessary for the testing and calibration of the commercial instruments. The whole work can be unreservedly recommended to all who have anything to do with electrical measuring instruments. Such a book has long been needed. The excellence of the present book exceeds expectations. It cannot be denied its position as the standard work upon its subject, and such it will remain for a very long time to come.

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